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THE CHOLERA PROSPECT IN 1893.

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THE most recent advices are that cholera is still raging in Russia, and that it exists in a slight degree in Hamburg and in some parts of France. The probabilities are, unless travel and immigration from Russia are immediately and strenuously interdicted, and unless the water-supply of Hamburg is made absolutely pure, that cholera will reappear in an epidemic form in Germany and France this spring and summer. But these two contingencies are within human control. Travelers and immigrants may be prevented from entering Germany, and purity of the water of Hamburg may be secured. While cholera has not been epidemic in any European port during the past winter, "sporadic" or isolated cases have occurred constantly in some of them. There are some persons—I will not say authorities—who assert that true Asiatic cholera exists in Paris during the entire year. Certainly it was there last summer. Assuming these statements to be facts, we have good reason to fear that this disease will reappear in New York harbor during the summer of 1893. But it is quite possible for the city of New York and the other parts of this country to be so protected, and for those coming here with the disease to be so isolated, as to prevent an epidemic in the United States.

Cholera is a much more simple disease to manage than the grip, for example, chiefly because we know more about its causes. Though we have now passed through a three-years' visitation by the latter-named disease, we are not any wiser as to its cause, and have no more means for its prevention, than when it re-attacked us

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in 1889. It is a malady which no human skill can avert. So far as we know, no special care, no formulated rules, will prevent the lofty and the lowly alike from being its victims; and even if the patient survive the attack of the disease, serious chronic affections which in some way or other prevent the patient from perfect recovery to health may result from it. Of cholera we know much more. We know its origin; we know that it is caused by a morbid germ (bacillus), propagated by water, milk, and foods of all kinds, which multiplies infinitely, but which is not often carried from one person to another, unless it actually enters the body. It is not usually sufficient to breathe the infected air of choleraic patients to become affected. I say "not usually sufficient" for the reason that cases have been said to occur in nurses who have been obliged to remove the excreta of patients, and in patients debilitated by other diseases, who have been kept in hospital wards with those suffering from cholera. But even in these instances it is probable that the bacillus was actually taken into the stomach. It remains true that those who are absolutely punctilious about food and drink that may carry the germ, generally escape the disease, however many may fall around them. But a bacillus from dried secretions, or on infected clothing, may become dissolved and enter the mouth, through the medium of the air, just as in the case of typhoid fever, which is also a disease not contagious from person to person, unless the typhoid germ enters the body. Again, it is not certain that every one thus having the germ in the body will be attacked with the disease; probably there must be a soil ready for it. In many instances good habits of life are a most effective guard against this fatal disease. It is indeed fatal, for at nearly the beginning of the twentieth century, having known of the cholera for a thousand years, we have perhaps no more means of combating it successfully, if it has once seized upon the human system, than we had when it first became known to civilization. It can hardly be said that the treatment in Hamburg in 1892 was any more successful than that in New York in 1832, when it first appeared on this side of the Atlantic.

The medical profession have generally accepted the belief that the bacillus discovered by Koch, in 1884, is the cause of cholera for the following reasons: *

I. It is almost always found in the stage of the disease known as collapse.

* Professor W. Gilman Thompson, "Pepper's Text-Book of Medicine."

II. When the disease does not exist, the bacillus is not found, and, with its disappearance it disappears.

III. The bacillus is found in the evacuations from the bowels, and in the smaller tubes of the great intestinal canal. It is just this region that is particularly affected by the disease.

IV. When the lower animals are inoculated with this bacillus, symptoms similar to those of Asiatic cholera are produced, and collapse and death occur.

The cholera bacillus, as described by Koch, looks like a comma, and can easily be picked out from all other products by an expert microscopist. This germ multiplies very rapidly in the intestinal canal. It can, however, be easily destroyed immediately after evacuation, here again following the parallel with the typhoid-fever germ.

If an epidemic of cholera occurs in America this year, it is impossible to say in advance what kind of a visitation it will be. It cannot be said that we had an epidemic during the last year. There were a few cases, perhaps a dozen, in New York city. Some medical writers profess to be able to draw the line between true Asiatic cholera and the severe cases of cholera morbus that are always with us, and they insist that, without Koch's bacillus, there can be no true cholera. This is probably true, though not yet absolutely proved. Yet, if the bacillus is not found in every case, it is no proof that the disease is not true Asiatic cholera, for the bacillus is a short-lived one in the human body. The lines of demarcation between diseases are not arbitrary, like geographical lines, but are dependent on a great many conditions, so that one disease may pass into another almost imperceptibly. The human body is so dependent upon the common supply of nourishment through the blood that bone and muscle and connective tissue are taken care of by the same nutrients, and invaded by the same disease, having, it is true, different characteristics, according to the part invaded. Small-pox is an entirely different disease from diphtheria, but cholera is not entirely different from the so-called cholera morbus—*cholera nostras*—that we have constantly in this country.

The characteristics of cholera may be briefly outlined.* It is a constitutional affection; that is to say, the whole organism suffers. The derivation of the word indicates that it was supposed to be an intestinal flux, for the etymology shows that it means a flow of

* Harold C. Ernst, "Reference Hand Book of the Medical Sciences."

bile. The disease suddenly develops, being marked by great uneasiness of the general system, followed by copious discharges from the bowels, and fainting. The attack may overtake the victim while he is walking on the street, in apparently good health. Sometimes it is preceded by a period of vague uneasiness, very rapid prostration, deep-seated colicky pains, loss of appetite, sweating, with more or less slowness of pulse, when the disease is always fully developed. The symptoms follow each other in such a manner as to be divided into two periods. In the first period the movement from the bowels and the vomiting are frequent, almost continuous, and the discharges are those characteristic of cholera, fluid and whitish, sometimes resembling a decoction of rice or oatmeal, sometimes thickened meal, very rarely giving traces of blood or bile. Usually there is also great thirst, pain in the stomach and prolonged hiccoughing, great cramps in the calves of the legs, the skin becomes blue and black, the nails livid, the fingers wrinkled. The whole body seems to be shrunken and shriveled, the eyes sunken and dull. The secretions of the body are arrested, the voice becomes a whisper, the nose is cold, the intellect obscured, the breathing difficult, and death follows in the midst of what is apparently a calm. When the patients escape death, they enter upon the second period, when the warmth returns to the body, the pulse improves, the face regains its color, vomiting is less frequent, and the diarrhea and discharges are no longer peculiar. The average duration of cholera is from one to three days, though sometimes death occurs in less than six hours. This is, of course, entirely unusual. When an epidemic is beginning, if the so-called *cholerine* cramps do not occur, the other symptoms are present, but in a milder form. Cholerine generally ends in recovery, and some authorities even deny the existence of such a disease.

As to the prevention of cholera, much has been said for and against strenuous maritime quarantine. The more ignorant the nation, the more intense and annoying the quarantine, whether maritime or on the land frontier. During the epidemic of 1885 in Italy and the south of France the Italians outdid themselves in ridiculous and inefficient and obnoxious rules to prevent perfectly well people from going from one country to the other. England perhaps lays less stress upon maritime quarantine than any other nation, but England is not a depot for immigration, and filthy immigrants from all parts of the world do not come to her shores as

they do to those of the United States. Those who visit England come only as actual travelers or immigrants *in transitu*. If the Russian immigrants who, having passed a few days in Hamburg, without any cleansing and other sanitary means, were put upon ships which they infected had been allowed free access to New York city last summer and autumn, they certainly would in a few days have so polluted water-sources that cholera would have become epidemic. We must, therefore, have quarantine regulations in this country. But, if a ship comes to New York harbor, even during the visitation of cholera, from a non-infected port, and has passed seven days without the occurrence of any case, it would be folly to retain the passengers on the ship. They should be allowed to land as soon as the facts about their condition are ascertained. If cholera has actually broken out upon a ship, the healthy passengers should certainly not be retained upon it, when the port is reached. They should be put on shore in comfortable quarters, and after a very short quarantine, if the disease does not break out among them, they should be released. If quarantine must be practised, it must be a civilized and humane quarantine, instead of imitating the Turks and Italians.

The authorities of cities should see to it that absolute cleanliness in the streets, courts, outhouses, stables, and public buildings is maintained. This should be the case the year round, whether cholera exists or not. But it is difficult to show the harm to public health from dirt. It is usually not observed by the people or by the authorities, and it is impossible to induce them to maintain the highest order of cleanliness unless something like an epidemic of cholera, or yellow fever, is threatened. New Orleans, under the military rule of General Butler, and Memphis, and Naples and Marseilles, after an epidemic had taught the authorities the necessity for absolute cleanliness, are striking examples of what sanitary engineering will accomplish for the public health. In the cities of Naples and Marseilles great sanitary works were undertaken which it will take years to complete. It is not an easy thing to learn what cleanliness is. An untrained man, however philanthropic, and however much of a statesman he may be, does not necessarily know when a city is clean, or how to clean it. The medical profession itself is just learning what is necessary to keep wounds clean, and to maintain cleanliness in the persons of surgeons and in their patients. The task of keeping inhabited centers, sources of water-supply, and means of travel free from the effects of the

daily and hourly pollution of human employments and human functions is one demanding expert knowledge, such as exists only in two professions—those of medicine and engineering. Yet one of the laws of the State of New York prevents a physician from being president of the board of health of the metropolis of the country. It is even very difficult to impress upon individuals the necessity for personal hygiene, in order to avoid disease. Many illnesses that are thought to be special visitations from Providence occur only because of the neglect of personal care. The time will probably come, however, when the human race will everywhere, with only exceptional instances, live out its life. It is perfectly possible to conceive of the domination of human intellect and human force being so universal as to abolish accidental death.

When an epidemic is threatened, the public are willing to practise virtues which they ignore when the pestilence is not stalking at noon-day. It may be well then for those in public positions to enjoin proper rules of life upon those dependent upon them. During an epidemic of any kind each individual should endeavor, as indeed he should under any circumstances, to maintain his mental equilibrium,—in other words, to keep cool. It is very difficult in our time to accomplish this, for the simple reason that some of the daily journals think it their duty to print sensational head-lines, and sometimes sensational paragraphs, which have very little actual foundation, but which excite and terrify the timid, and sometimes even the brave-hearted. The writer was once in a foreign country where an epidemic of cholera was prevalent. He never knew how violent it was until he received the newspapers from his own country describing it. Such an effect did they have upon his friends that he was written to by several of them, urging him to fly at once, when, as a matter of fact, he was in no more danger than he would have been in his own dwelling at home. The cholera only prevailed among the vicious, intemperate, and ignorant classes, who violated the most ordinary rules of personal cleanliness, and yet the news sent from the same places intimated that every individual even in places entirely free from cholera was likely soon to be attacked and swept off the earth. I am not in favor of governmental censorship of the press, but I am very earnest in my hope that the press in our country will be moderate and judicial in statement should cholera ever become epidemic among us. I think that it can be properly urged upon the citizens of New York and adjacent cities, should the cholera appear, that they refrain from reading about it,

unless they are sanitary or medical experts, wishing to learn all they possibly can as to the progress of the epidemic, and are able to look upon it in a scientific and cold-blooded way. The public should drink none of the ordinary water-supply of the region in which cholera prevails, no matter whether it is certainly contaminated or not. No water ought to be drunk unless it has been boiled, or unless it be the water from some locality known to be absolutely free from the possibility of infection. In the second place, uncooked vegetables and uncooked fruits should not be eaten. It was a great trial to the people of Paris, when the cholera raged in the south of France in 1885, to give up their delicious melons, but it was a very wise precaution, because the medical experts have shown us that the germs of the disease are likely to lie and germinate upon uncooked vegetables and fruit, and thus be propagated, to a greater extent than in perhaps any other way, except through water or milk.

Those who employ a large number of men in factories, mills, or on routes of transportation ought to secure the simple directions from the board of health, and cause them to be printed, publicly posted, and circulated among the families of the employés, and all through trains should have a physician and hospital supplies on board. A great field will be opened to the sanitary engineers of the world in protecting water-supplies, and in general work to prevent pollution from the soil. It is to be hoped that this will also be done in New York, although I can see no evidence as yet that the public authorities appreciate fully the necessity of medical and sanitary experts in the prevention of epidemics. One of the latest signs of the failure of legislative bodies and public authorities to appreciate in the United States what has been done in other countries by sanitary engineering is the crude method adopted to free the Croton watershed from pollution. Land contiguous to the water-supply has been purchased, or seized to be afterwards purchased, and public officials have gone on the soil and removed and burned property of various kinds, apparently without any definite plan of preventing the pollution, which may result from the presence of a few tramps, the day after the houses and stables and outhouses have been destroyed by fire. If the government is to purchase all the land adjacent to the water-supply of all the cities and towns, we shall soon have a debt beyond even the financial capacity of our country. We are the only people, so far as I am informed, that have ever sought this means of relief from the neg-

lect of sanitary laws. Without buying a foot of land, it is possible, under a proper sanitary police, the supply having first been treated by experts, who have prepared a system of protection, to maintain purity in the water of all the great cities and towns. We are just in the dawn of knowledge on this point. Civilians having forgotten the war of 1812, when "the West Point Academy might be said to have decided next to the navy the result of the war,"* had to learn at great cost during the late civil war that invading countries and defending them are matters of scientific study, the art of which must be learned from experts. West Point proved to be of more value than the farm and country home in training leaders of armies. So in the great questions involved in the approach of epidemics, protection can only be had by following the advice of expert authority.

As has been said already, cholera is a disease that can be more effectually guarded against than many which do not cause as much alarm. If the quarantine regulations are honestly maintained, with skill and scientific knowledge, there need be no extension of the disease from our harbor. Perhaps it will not even be brought there. The effect upon the World's Columbian Exposition by the appearance of the cholera in New York would, in the nature of things, be extremely bad. Europeans, having read much of the scenes in our harbor last year, would be afraid of their repetition, even if they did not fear the disease itself. The precautions taken by the general government are, however, so careful and faithful, in the placing of medical officers of our own at every port of departure, that it is hardly to be feared that any such numbers of infected ships can possibly arrive in New York as came from Hamburg last year. Public instruction should be given by the government, at the beginning of an epidemic, or even in anticipation of an epidemic. This is being done already, to some extent, in New York city, where lectures by physicians are being given to the poorer classes as to what to do in order to avoid cholera. If they could be supplemented by practical instruction—object-lessons as to the danger of neglected garbage, drains, and traps; if the ordinary plumbers could also be taken in hand, and proper police regulations enforced, in all these respects—even if the cholera did appear here, it would not acquire a firm or lasting hold. It is always to be remembered that cholera is an exotic in America, and indeed in all Europe. It is really a part of the soil only in India, though

* Henry Adams's "History of the United States,—Monroe's Administration."

perhaps it is becoming a natural disease in Russia. Being thus able to locate its point of origin, we can restrain its virulence.

Dried evacuations upon bed-clothing retain their poisonous properties for an indefinite period of time; hence the need of the greatest care that the materials which have been used by choleraic patients should be either absolutely destroyed, or rendered free from any source of contamination. While dirt and dampness will not of themselves produce cholera, without the presence of the specific germ, both dirt and dampness furnish the means for the infinite increase of the specific bacillus. Once allow the cholera germs to infect the water-supply of a city, and, that water be generally partaken of, the city is doomed. But that the disease is not contagious in the sense of being carried from one person to another, by personal contact, ought to be a source of great satisfaction and congratulation to all who may be exposed to an epidemic.

Let us hope that the present anxiety about the appearance of cholera in the United States will lead to a general recognition of the fact that expert knowledge of the two professions of medicine and engineering are the only safe means to which the public may look for a protection which is more efficacious against cholera than anything as yet known to arrest epidemics of grip, diphtheria, and scarlet fever. It has hitherto been supposed that the germs of cholera, in India, could never be exterminated, but Dr. Telyafus, of Tiflis in Russia,* seems to think that the disease could be strangled in the place of its birth. This is the delta of the Ganges, a low-lying space of about 7500 square miles. The soil here is very moist, and contains the remains of many forms of vegetable and animal life in a state of decay. Cholera has raged here for hundreds, and perhaps for thousands, of years, and after very severe rains, or from other causes not well understood, it passes out from this delta into the neighboring countries, and thus over the entire world. The present epidemic of cholera in Europe is the fifth invasion recorded by history. Dr. Telyafus thinks, because the plague was stamped out of the Nile delta, that similar measures might purify that of the Ganges. He advises cremation of the dead in India, instead of throwing the bodies into the river, as well as the planting of extensive eucalyptus groves, as has been done in Algiers. Sanitary engineering and the planting of these trees have reclaimed large and hitherto uninhabitable marshes in Algiers, so that they are now cultivated and inhabited by a healthy population.

* *Medical Record*, April 8, 1893.

ETHICS OF ARCHITECTURAL COMPETITIONS.

By John M. Carrère.

A BILL was passed lately by the senate and house of representatives, and signed by the president, authorizing the secretary of the treasury to hereafter obtain designs for United States government buildings by competition among the architects of the country at large, and there is no doubt among those interested in such matters that this is a great step in advance.

The position of supervising architect, created at a time when our public buildings were less numerous, and scattered over a relatively small area, has become merely clerical in its functions, owing to the increased number of these buildings, amounting to as many as three hundred at one time, involving an expenditure of over $20,000,000 per annum, and spreading over the entire United States. It stands to reason that the designing of such a number of buildings, and the proper execution of them, had to be delegated to assistants. How pernicious the whole scheme, which was never satisfactory, has become is clearly demonstrated by the results obtained. As stated, therefore, the step is one in advance, because it changes the entire system, and distributes the work among the architects at large; and we may expect hereafter, under favorable circumstances, as good results for government work as for private work.

In view of the great influence that this decision will have upon architecture in this country, the question is whether the manner in which government work will be distributed is the best,—namely, by competition; and if it is, how the competition should be conducted so as to obtain the best possible results.

Architectural competitions, in the judgment of most architects, are a snare and a delusion. The principle of bringing men into rivalry in the solution of the same problem with the hope of producing the best possible work seems to be a correct one, but, even disregarding all other practical reasons, it fails to produce the desired results, because in the manner of presenting the solution—namely, by drawings—it is impossible, no matter how fully the drawings illustrate the idea, to give a complete conception of the work as it will appear. This would be true, even if the judges who

select this work were always as able as those who are competing; and there is no doubt that in architecture, as in all other liberal arts and professions, the best results are generally obtained by selecting a man on his record, selecting him for what he has actually accomplished, and intrusting the work to him without competition.

A competition may result in bringing out hidden talent, and give new men opportunities which they would not otherwise secure, but the older men who have their legitimate work to attend to, which cannot be neglected, cannot be drawn into competitions for the mere sake of a chance to increase their practice, perhaps at the risk of unfair treatment, of prejudiced decisions, and of unreasonable demands upon their time; so that it is very seldom that the best men will consent to enter into competitions, and the object of the same is thereby immediately defeated.

The system of paid competitions, which has been lately adopted (where a limited number of men are selected, and offered a nominal sum to present drawings, it being sometimes understood that all other architects can send in drawings without such remuneration), also fails to meet with the approval of the leading architects, for it is really a *gamble*, a *speculation*, and therefore the system does not fully overcome the difficulty.

It is natural, as long as architects are expected to furnish for $500 virtually preliminary drawings for work entailing very often an expenditure of $1,000,000 for which it is agreed the world over that architects shall charge 1 per cent. or $10,000, that the *best* men, the *busy* men, will not consent to compete, though the layman is only too anxious to have a competition on these terms.

If competitions are ever to be a success, they should in the first place, in the writer's opinion, be made such as to commend themselves to the attention of the *entire profession*. The men with established reputations will not look upon competitions favorably, and will not take part in them regularly, until a regular schedule has been established, making uniform charges for competition drawings, in the same manner as for other professional services. Such a schedule, with all allowance for the privilege offered to compete, will place the architect's services on a business basis,—which is the only possible one. It will reduce the number of competitions and of the competitors,—confining them to the most important buildings,—and elevate the standard of the work. These will be the only terms upon which the leading men will *always* be willing to enter competitions for buildings other than public buildings.

In the matter of public buildings it is somewhat different, from the fact that the character of the building is one which not only promises renown and honor, resulting from possible success, but which gives the true architect the only opportunity for studying and designing monumental art; and for the sake of *this opportunity*, if the competition is properly conducted, the leading architects in this country would probably consent to compete.

Now, with the above conditions established, what is at present the object of a competition, and what should the object of a competition be?

The object of a competition at present seems to be a scramble for ideas. As stated to the writer by a committee-man in a paid competition for a large building: "We have ten competitors,—we can only select one architect,—but we expect to get at least $500 worth of '*ideas*' out of each one of the others."

In such competitions the result at the best is one of mere chance, depending on ingenuity of arrangement, on the scheme, and on everything in fact but architectural merit. A competition should not be the *selection of a plan*, but the selection of *an architect*. Selected not for his ingenuity, but for his composition and his skill; not for his scheme, which should be the program, and which should be furnished to him to develop, but for the ability with which he has accomplished this development.

To obtain this result, it is necessary, in the first place, that the program should be as complete as possible, giving the architect all the information obtainable concerning the requirements of the building, the different spaces, their sizes, how to be occupied, in what relation to each other they are to be used, and in important buildings, such as a city hall, for instance, a short and concise history of the manner in which the government is conducted, the functions of the different officials, their relation to the community and to each other; as much, in fact, as will enable the architect to fully understand the purpose of his building and the spirit in which it should be designed.

All of these matters are not such as the architect should be left to find out; they should be given to him, and should be based on actual experience in such matters: this applies to all buildings, commercial as well as government buildings. Why should an architect, for instance, determine the most advantageous arrangement of an office building, when these conditions vary for every city, and for different parts of the same city,—really for every new

building,—and are best decided by the client in consultation with real estate men, and other experts, whose business it is to study such problems from their financial and purely utilitarian standpoint.

After the competing architects have had time to study the problem and to become familiar with the same, it would be wise for the committee and its experts to hold several meetings,—which all the competitors would attend,—for the purpose of discussing the program and its requirements, and altering it if necessary, by mutual consent of a majority of architects, with the approval of a majority of the committee. The competing architects are then fully prepared to study the problem with full knowledge of the same, and they can then depart from the program as much as they dare risk, or as in their judgment would improve the same, and their duty becomes one of composition, of architecture.

Every other possible element of chance should be eliminated from the competition. Any special features, such as a dome, a tower, the location of any particular feature, the general disposition of the building on the ground, or what is known as the block plan, even the style of architecture, if such a thing is admissible where it is to form an element in the decision, should be plainly stated. The question is not whether this or that man will think of having a dome, *but who is the man that can design the best dome; and this same principle applies to every part of the building.*

As is now usual, the number of drawings should be distinctly stated, and none others allowed. The scale of the drawings should be uniform for all of the competitors, but as the drawings are technical, and of no value except as such, they should *always* be rendered technically, from an architect's standpoint. No perspectives should be required, in which the good drawing by a clever artist, employed to assist in rendering the same, may deceive a whole committee as to the merits of a composition.

The drawings should be plans, sections, and elevations, all rendered so as to establish distinctly the composition and the proportions, and made of such a character as to absolutely require to be passed upon by experts. For purposes of comparison the manner of rendering should also be determined. The number of drawings should *always* be as few as possible,—only as many as necessary to place the composition fully before the jury,—and their scale should be as small as practicable, and all drudgery and drawing should be reduced as much as possible, so as to enable the architect to devote

his entire time to the study of proportion and composition, and not to the rendering of elaborate drawings. The busy men have not the time, the younger men have not the means, to enter into such elaborations. One full-size detail, or a large scale drawing, or both, of some prominent part of the building, drawn by the competitor himself, should be asked, to establish the ability of the architect to execute what he has composed, and this will prove of a good deal more value than the usual perspectives,— and if a perspective is found necessary, for a committee for instance, it should be merely technical in its presentation, almost a *block perspective.*

Every other possible safeguard, both as to avoiding any chance hit on the one hand, and any possible unfairness on the other, should be resorted to. No communications should take place between competitors and committee, except in writing, and such communications and the replies should be furnished to every competitor. If the competition is a public one, all communications should be published in the newspapers.

The employment of the successful architect in accordance with the terms approved and adopted by the American Institute of Architects should be guaranteed, his competition drawings being considered as the equivalent of preliminary drawings. All other competitors should be guaranteed that their plans will be returned to them and will remain their property, and that they will not be used in part or in whole, excepting by proper compensation, the value of which will be established by the jury.

In public competitions prizes should be distributed,—the manner, number, and amount being adjusted to suit the nature and importance of the competitions.

If the competition is a public one, the drawings should be sent without signature or mark ; they should be simply numbered consecutively, as received, the envelope with the author's name being numbered likewise ; so that no one, not even the author of the design, knows his number. Every possible chance for " wire-pulling " or undue influence should be guarded against, unless the competition is to become a mere farce. If the competition is a limited one, every drawing should be *signed by its author.*

After the jury have passed upon the drawings and reached a decision, the drawings should be exhibited before this decision is made official, to permit a full discusion of their merits,—either by the public or by those interested,—and avoid a possible blunder, which, once made, in most cases is not easily remedied.

The jury should then meet again, and revise their decision if necessary, otherwise confirm it, and the drawings should be exhibited again after the decision is made official; for such competitions would become educational for the public, but principally so for the profession. The exhibition before the decision might be limited to professional men,—and under these circumstances it would be interesting, and perhaps prove a great success, to have a discussion of the plans, and a vote upon the same, prior to the final decision.

Concerning the manner in which the architect should be selected, there is absolutely no doubt in the mind of any one who has studied such matters that the jury should be composed of men any one of whom could build such a monument himself,—not *construct* it, but *compose* it, *plan* it, and *build* it. It should consist of architects only.

The building, if well planned and well composed, will calculate and construct itself. The better the plan and the composition, the easier it will be to execute it, and no one but an architect can compose architecture. Do not select any man, therefore, to pass judgment for any other reason than what he has actually done.

If competitions can be conducted with the understanding that it is the *architect* that is wanted, the duty of the jury will consist in classifying the competitors according to merit. This jury should be engaged from the very beginning; should consist of not less than three men, to avoid possible personal prejudices; should prepare the program, assisted by the committee and with the advice of experts and specialists; and should conduct the competition in consultation with the building committee, working together throughout. They should discuss the merits of the drawings and of the architects, with the committee, and obtain fully their views, but at this point the committee should retire, and leave it entirely to the jury to decide the competition.

Such a jury would only be willing to serve in special cases, without compensation; and as only the best men can be selected, they would have to be well compensated; but if a competition is worth having at all, such matters should not enter into consideration, and if they do enter into consideration, there is no reason for a competition.

In conclusion, the writer would state that, *unless the purpose of a competition is the selection of an architect*, in his judgment it would always be better not to have a competition, but to give the work to one architect, *on his record;* or to have a consultation of leading

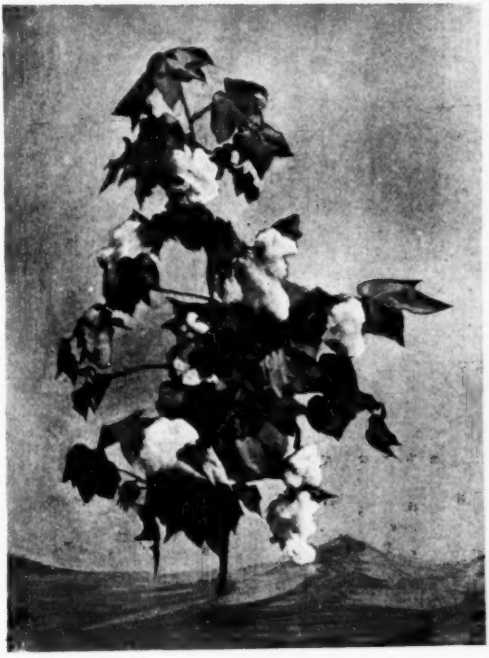
architects, employed and paid to discuss the problem from the practical and utilitarian standpoint, and with the assistance of experts and specialists, the client or committee, and such other persons as have had actual experience with the problem at hand, decide on the best solution, and establish the scheme ; the architect being engaged beforehand and taking part in the discussion, or a competition being established on the lines of this discussion, the scheme of which would then form the program for the selection of an architect.

Many of the competitions which have taken place lately have suggested many very excellent features, have created a better feeling among the profession, and unconsciously contributed to the raising of the standard of work. It is really to Professor William R. Ware, of Columbia College, more than to any one person, that we owe the firm establishment in practice, and the general recognition by the public, of the general principles expressed in the Boston committee's report of 1876, of which he was a member, and which was the first comprehensive report on this subject in this country.

COTTON AS A FACTOR IN PROGRESS.*

By D. A. Tompkins.

THE development of the production of cotton in the United States within a single century from insignificant proportions to 9,000,000 bales a year, considered in all its relations to our industrial progress, is without a parallel in history. First of all, it is a sufficient answer to the charge so often made against the southern part of the United States that the people are without enterprise or mechanical ingenuity. It may not be going too far to assert that everything the northern part of the Union has accomplished, put together, has not affected the welfare of so many people in the world, or reached so far in its effects, as what has been done in the cotton industry in the South. It may be answered: "The South alone is adapted to the production of cotton; if it would only grow in the North, a different showing might have been made by that section." But cotton grows in India, in Egypt, in China, and in South America, and a people cannot be without enterprise who, in competition with such a wide-



THE COTTON PLANT.

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spread cotton area,—in many parts of which the plant has been cultivated for centuries upon centuries,—in less than one hundred years are able to show a production far exceeding that of all the rest of the world.

In 1820 the cotton crop of the United States amounted to about 400,000 bales; in 1892 the yield reached nearly 9,000,000 bales. During the greater part of the interval the price has been about ten to twelve cents per pound, but it has been as low as five cents, and as high as twenty-seven cents, leaving out of account the years of the war (1860 to 1864), when the South practically stopped producing cotton. Estimating 500 pounds to the bale, and the price

ORDINARY COTTON-PICKING SCENE.

at ten cents per pound, the crop of 1820 would have been worth, in round numbers, $20,000,000. On the same basis the crop of 1892 would have a value of $450,000,000. This great increase in production has been made in a section to which there has been no such constant tide of immigration as has been experienced by other parts of the United States, and for this reason alone the result reflects great credit upon the people who have accomplished it.

This great achievement is the result of three things combined, namely: (1) the enterprise and energy of the people; (2) the invention of the cotton gin; and (3) the designing of buildings and mechanical appliances by which the gin may be economically operated.

COTTON-PICKING—JAMES S. RICHARDSON'S "GLENCOE" PLANTATION, BOLIVAR COUNTY, MISSISSIPPI.

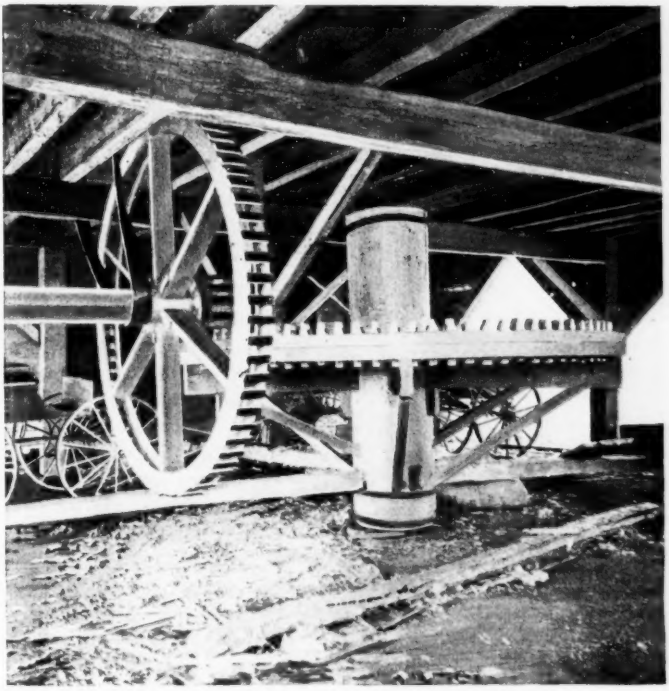
OLD PLANTATION GIN AND SCREW IN OPERATION.

It appears to be commonly believed that the successful production of large cotton crops in the United States is due to the invention of the gin alone. While this has been an essential element in the problem, yet Egypt, India, and South America, which have the advantage of perfected gins, due to the inventions made in America, produce cotton neither so cheaply nor in such quantities as in the United States. I am far from wishing to take from Mr. Eli Whitney any of the credit that attaches to his name for the invention of the cotton-gin. He stands in my estimation at the head of the list of all those whose inventions have been of benefit to mankind. In the invention of the cotton-gin there is glory enough to immortalize Whitney's name with plenty to spare for the credit of others who did valuable and essential work in the development of what he produced.

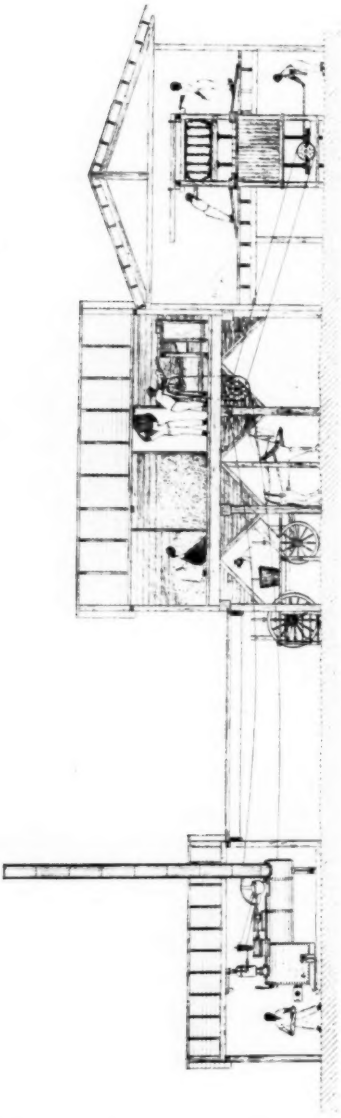
When Mr. Whitney first visited Savannah, much had already been accomplished in the way of creating conditions for the more economical production of cotton. A commission had been appointed by the State of Georgia, charged with the duty of causing a machine to be devised for the separation of the lint of the cotton from the

seed. Mr. Josiah Watkins had in operation a crude machine similar in many respects to the more nearly perfect gin which Whitney constructed. The substitution of the saw for wire spikes seems to have been first been made by Col. O. A. Bull, of La Grange, Georgia, and a little later, but independently, by Hogden Holmes, of Fairfield county, South Carolina, and it was this improvement, more than any other one thing, that put the cotton-gin in shape to become such an important factor in the development of the cotton interest.

While the times were ripe for the invention of the cotton-gin, and many persons were working at the problem, and while the gin would probably have been invented even had Whitney never gone to the South, he was just the right man to quickly take up the suggestion of the Georgia State commission. He saw the Watkins



MECHANISM OF OLD COTTON-GIN HORSE POWER.

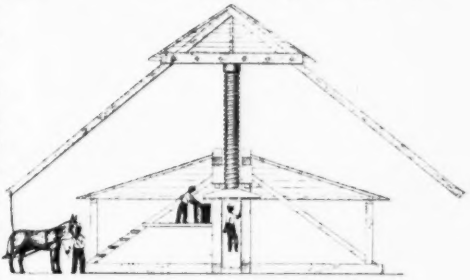


OLD PLANTATION GIN-HOUSE, WITH STEAM-POWER AND POWER-PRESS ADDED SINCE THE WAR.

machine, worked on the problem himself, heard of Holmes's improvement and went to see it, and to his own ideas and work he added the best of what he gathered from various other workers on the same problem. The result was the Whitney gin.

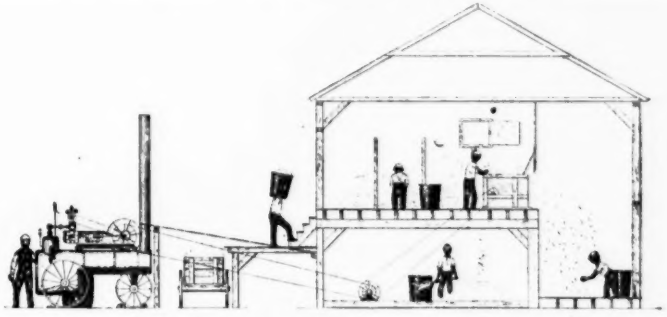
A machine having been invented that would separate the lint from the seed, there was at once a need for a proper house in which to operate it, and some power to drive it. Mule-power was the most available, and wood was the most suitable material both for the building and the machinery for utilizing the power. Therefore a series of wooden wheels, gears, and levers were devised by some one whose name is now lost. The house was built on posts in such a way that the machinery could be operated by mules under it. Considering the limited facilities at hand, this running-gear for a gin-house for the utilization of mule-power exhibits marked mechanical ingenuity and adaptability, the lack of which in other countries prevents such results in the production of cotton as have been attained here.

When the gin, the gin-house with its appliances, and the baling-screw had all been developed to a condition of practical success, the production of cotton became at once very profitable. The desire to embark in the business made a demand for labor and increased the price of slaves. The slaves of the Northern States were purchased, and still more were needed, which demand was partly filled by a trade with Africa itself, the ships of England and New England entering briskly into the business.

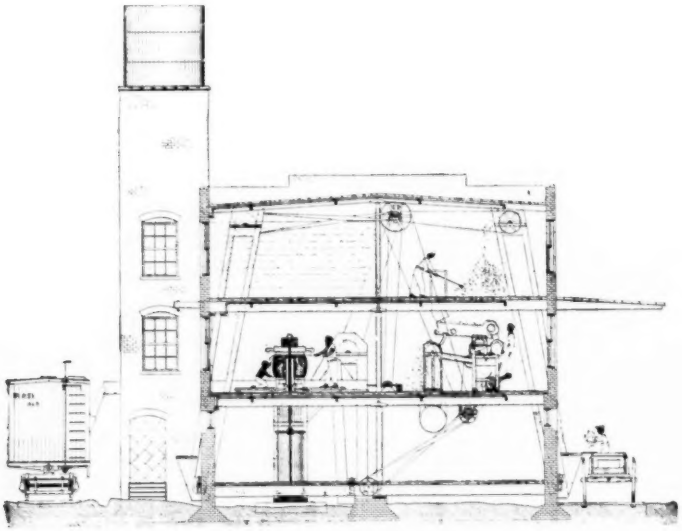


OLD PLANTATION COTTON-SCREW.

Slavery existed in New England about one hundred years before it was tolerated in the South. Up to the time when the appliances just described gave such a stimulus to cotton-planting, general manufactures had prospered more in the South than in any other part of the Union. Even as late as 1810, according to the United States census for that year, the manufactured products of Virginia, the Carolinas, and Georgia exceeded in variety and value those of all New England. While the production of cotton remained profitable, the growth of slavery stifled manufactures, and that interest steadily declined. Nor were any further improvements made in the appliances or methods for the preparation of cotton for the market. The standard ante-bellum gin, gin-house,



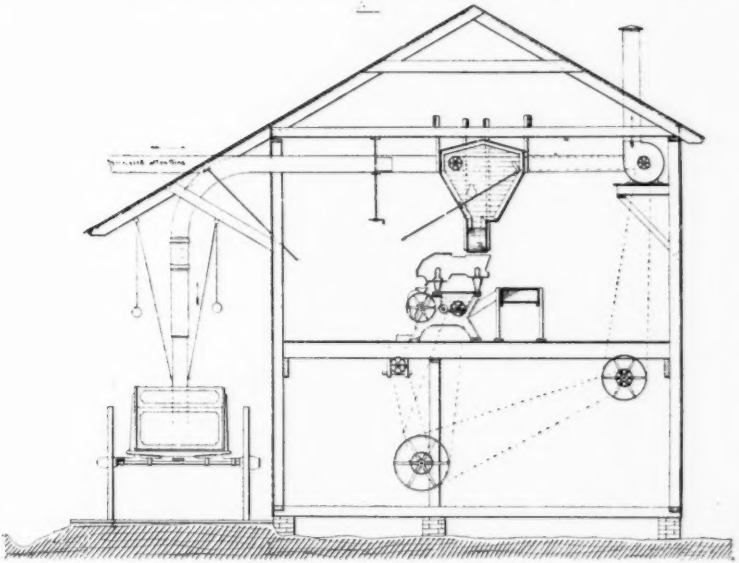
OLD PLANTATION GIN-HOUSE WITH STEAM ADDED.



SECTIONAL END ELEVATION OF MODERN GINNERY.

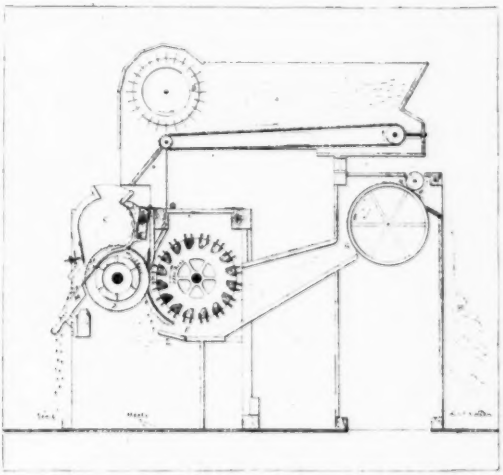
and screw were practically the same in 1860 as in 1820. Many of those of 1860 were larger and finer than those built a quarter-century earlier, but there was scarcely a new idea in the design. The inheritor of slaves had become an aristocrat, and the cunning of his forefather in mechanical art had been lost. But while lost temporarily, it must have lived in the bones of the people, because no sooner had the late war ended, wiping slavery out of existence, than one improvement after another began rapidly to appear. Before the war mule-power, slave-labor, and wooden machinery were universally used for the preparation of cotton for market. Every plantation had its gin and gin-house, and, barring only the separation of the lint from the seed and packing, all the operations in handling cotton were performed by man power. The cotton was packed by hand, carried into the gin-house in baskets by laborers, carried to the gin by laborers, fed to the gin by laborers, pushed into the lint-room, carried to the screw, packed in the box of the screw and bound with ropes, all by hand. Slave-labor was abundant and cost so little that there was no incentive to improvement.

Subsequent to the war a feeder was invented for the gin, to save the labor of hand feeding. Then came a condenser, to save



SECTIONAL END OF A MODERN GINNERY.

labor in the lint-room, then a hand-press that could be operated in the lint room of the gin-house, to save carrying the cotton to the screw, then a power-press, then cotton elevators, some using spiked belts and some the suction of air. Within thirty years the spirit of enterprise, invention, and improvement in the people of the South has not only revived, but



SECTIONAL SIDE ELEVATION OF MODERN GIN, FEEDER, AND CONDENSER.

the entire method and all the machinery and appliances for preparing cotton for the market have been revolutionized.

The cost of ginning 1500 pounds of seed cotton and of baling the lint is to-day only about one-fifth of the cost in 1870. The plantation gin-house and screw have been supplanted almost entirely by the modern ginneries, which are centrally located and are manufacturing-plants rather than plantation equipments. Many of them are incorporated as parts of plants in which the lint is separated from the seed and baled, the oil is taken from the seed, and the cake is ground into meal to be used as a fertilizer or cattle feed, as the markets may demand.

In almost every community in the South there may now be

COTTON AUCTION-SALES, M'KINNEY, TEXAS.

found a manufacturing-plant known as a gin, oil-mill, and fertilizer-works. These gin cotton, crush cotton-seed for cotton-seed oil, and, buying some of the ingredients which are used with cotton-seed meal, mix commercial fertilizers. Out of this development has come the further business of fattening cattle on cotton-seed hulls and cotton-seed meal. Recently a large business has been developed by these factories in preparing a stock food made of cotton-seed hulls and meal, mixed. Before the war the seed were a waste product; ten years ago the hulls were used for fuel only. Last year cotton-seed sold at $20 per ton and the hulls at from $3 to $5 per ton.

The most expensive item now left in the production of cotton is the cost of picking the fiber from the stalks in the field. This opportunity for the exercise of ingenuity has not been neglected during the last few years. Numerous patents have been issued for cotton-harvesters, many of which are absolutely without merit, but some of which are marvelously ingenious. One that seems, so far, to have come nearest to doing commercially successful work is that of Mr. C. T. Mason, of South Carolina. The extent of the incentive for the solution of this problem may be judged from the following estimate :

COTTON COMPRESS AT M'KINNEY, TEXAS.

The price now paid for picking cotton is from 50 to 75 cents per hundred pounds. About 1500 pounds of seed and cotton are required to make a ball of lint weighing 500 pounds. The cost of picking 1500 pounds of cotton at, say 60 cents per hundred, would be $9. Therefore to pick ten million bales, which limit it is assumed will be reached in the near future, would cost, at present prices, $90,000,000. It is claimed by the cotton-harvester inventors that a machine can be made which with one mule and one laborer can pick or gather 4000 pounds of seed cotton per day.

COLORED PLANTATION HANDS IN THE SOUTH.

whereas the picking of 150 to 200 pounds by hand is a good day's work.

The following table will give some idea of the increase in production of cotton every tenth year, and of the value of each crop included in the list, since 1820, expressed in round numbers. Values are all based on the rate of 10 cents per pound, and an average weight per ball of 500 pounds.

Year.	Production in bales.	Value at 10 cents ℔ pound.
1820	400,000	$ 20,000,000
1830	1,000,000	50,000,000
1840	1,600,000	80,000,000
1850	2,250,000	112,500,000
1860	3,600,000	180,000,000
1870	4,250,000	212,500 000
1880	6,600,000	330,000,000
1890	8,000,000	400,000,000

As has been stated already, the seed were before the war a waste product except where used in the Southeast to a limited extent as a fertilizer. Since the war the cotton-seed oil business has been developed to such an extent that in the current season about

MODERN STEAM COTTON-GINNERY.

THE VICTOR COTTON-MILL, CHARLOTTE, N. C. (BUILT 1888.)

1,500,000 tons of seed will be crushed for oil and other products. Out of these seed come the following products, against which their values are shown :

50,000,000 gallons cotton oil	@	$ 0.50	$25,000,000
700,000 tons hulls	@	4.00	2,800,000
500 000 tons meal	@	20 00	10,000,000
50,000,000 pounds short lint	@	.03	1,500,000
Total			$39,300,000

This much comes out of what was in the days of slavery almost entirely wasted.

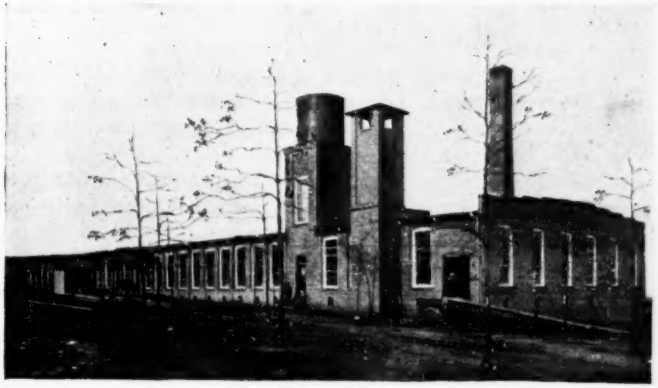
It is not alone in the utilization of cotton-seed that the revived mechanical genius of the South has been exhibited, but in the manufacture of cotton into yarns and cloth as well. In a region of country reaching along the foothills of the mountains from Lynchburgh, Virginia, to Atlanta, Georgia, almost every town has one or more cotton-factories, built since the war. Many factories have been built on the water-powers in the country, and towns have grown up around them. At first only coarse goods were attempted ; then finer and finer products, by degrees. While as yet no very fine goods have been produced, enough has been done to prove that as capital accumulates and the owners acquire knowledge of the business and the operatives improve in skill, there is no more limit to the quality of the goods that may be made about Charlotte, North Carolina, than those that may be made about Lowell, Massachusetts, or Manchester, England.

The present industrial development in America, in England, and

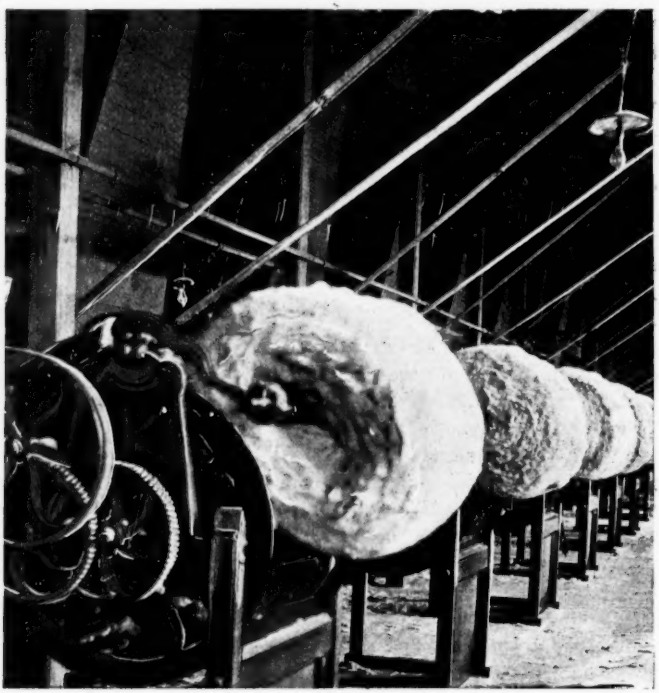
on the continent had its beginning in four events, the absence of any one of which would have destroyed the greater portion of the value of the other three. These were the invention of the power-spindle, the invention of the power-loom, the invention of the cotton-gin, and the response to these of the southern portion of the United States in the production of the raw material for the utilization of these inventions.

It is not alone of interest that the impetus given to the production of cotton by mechanical inventions has added to the productive capacity of Southern agriculture and increased the wealth of an important section of the United States. Every family in the whole country has been benefited by the cheapening of clothing and other articles made of cotton, by reason of the marvelous increase in the extent of production of this fiber. The manufacturing and commercial interests of New England have been promoted to a remarkable extent by the same cause, to say nothing of the effect upon the cotton-manufacturing interests in England and other parts of the world, and the increase in the consumption of cotton goods due to the wonderful cheapening of their cost. The single item of the benefit to the shipping interests due to the cotton-carrying trade is of great extent. Cotton, more than any other one item of freight, has been the basis of transatlantic commerce.

Leaving aside these general considerations of benefits at home and abroad, to industry and commerce, and the increased comfort of the human race, we may again recur to the importance to the



ATHERTON COTTON-MILL, CHARLOTTE, N. C. (FINISHED 1893.)



TAKING SHORT LINT FROM COTTON IN AN OIL-MILL.

Southern States of the cotton-growing industry in a great variety of directions. Cotton as a basis of wealth and of productive industry has made possible the growth of prosperous cities and towns where, at least before the development of mineral resources in the South, nothing of the kind could have existed. The cotton interest has contributed to the success of all transportation systems in the South. Even the development of mining in the South has been hastened by the need of iron by railroad companies for the transportation of the cotton and in the manufacture of cotton machinery, and the need of coal for purposes to which cotton has given rise. The cotton-growing industry, in short, has furnished what opportunity has existed in this large portion of the Union for the employment of engineering and mechanical skill, contributing thus to every branch of material progress.

THE GRAVITY SYSTEM OF RAPID TRANSIT.

By Major Benjamin S. Henning.

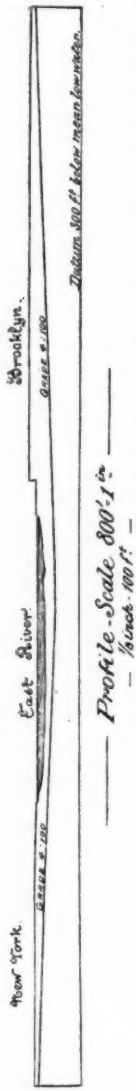
IT has often been observed by experienced engineers that a great mistake was made in not raising the tracks at the stations of the New York elevated railways two or three feet above the general level, so that the trains might have the potent aid of gravity in getting a full headway of speed on a down-grade, with a like advantage in stopping on an up-grade. Such an improvement would of course be a disadvantage to fast through trains, for which a level track is best ; but the records of travel on the roads will show that 90 per cent. or more of the traffic is local. In other words, *to render the service which is required* of the elevated roads, it is necessary to provide for *stops at every station ;* and hence the idea is now prominently before the public of permitting the company to construct a third track for the accommodation of through express trains, running down at certain hours in the morning and up at certain hours in the evening.

Now, if gravity would afford such a manifest advantage in the case of the elevated roads, it clearly points the way for the application of the same principle to the whole distance between stations. In short, why not give the track a gradual incline to the center of the distance between the stations, and a corresponding ascent the remaining distance? It is a law in physics that an object dropped from any height, describing a curve, will rise to the same height, less the retardation by air and friction, as demonstrated by the principle upon which the pendulum in a clock operates, a very small spring in the mechanism of the clock serving to keep a comparatively ponderous pendulum in constant motion by giving it a slight impetus at each end of its vertical curved motion.

There is, in fact, now in existence a corporation designed for the construction of an underground road upon exactly this system, between the City Hall in New York and the City Hall in Brooklyn, running beneath the East river. Some of the wealthiest men in the two cities have interested themselves in the organization under advice of skilled engineers of the highest standing and application has been made for the necessary city franchise.

On the following page is shown a simple illustration of the plan,

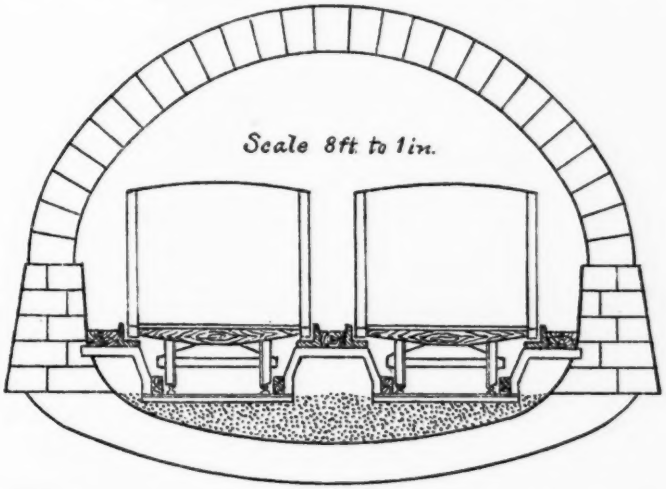
which will explain itself fully. Briefly stated, the idea is to commence in New York at the intersection of Spruce and Nassau streets, with an underground platform 16 feet below the surface of the street, to which access will be given by a broad and easy stairway, requiring an opening at the surface of about 20 by 80 feet. Commencing with a grade of about 2 per cent. for the first 360 feet, the track will then descend at a grade of about 4 per cent. to near the middle of the East river, and then ascend at a similar incline on the opposite side; thus making a tunnel with such slight grades that a horse and wagon could be driven through it without difficulty. On the Brooklyn side the station will be in the vicinity of the City Hall, and with similar conditions as on the New York side. Both the cars and the tunnel will be brilliantly lighted with incandescent electric lights, and thoroughly ventilated by air-shafts. Steam being unfit for underground railways, and neither electric nor compressed-air motors having as yet been developed to a point of efficiency for such heavy traffic, a short cable system will be employed at each end. Taking hold of the train at the start, the grip will be so constructed as to automatically release its hold so soon as gravity increases the speed of the train beyond that of the cable; and in like manner at the other end the grip will take hold at the moment the speed of the train becomes less than that of the cable.



The cars will be constructed after the excursion model, with sliding doors opening on the sides, and all operated by a crank at the end of the car; each car seating 96 passengers, or a total of 576 for a train of six cars. With a maximum speed of 52 miles an hour in the center, and an intermission of $2\frac{1}{2}$ minutes between trains, the capacity per hour would be 14,400 passengers, all seated. The trains will be operated upon the block system, no train being permitted to depart till the one preceding it has arrived at the opposite station.

In the factor of safety, such a system offers important advantages. Collisions are impossible. The

rails will be of the heaviest type, and, being away from the influence of the weather, will be less liable to break ; and as weight of rolling stock is rather an advantage than a detriment, wheels and axles can be heavy and strong and of the best material. In case of the breakage of wheel or axle, the car will simply settle down a few inches on rollers, running on a separate friction track just beneath the sills of the cars, as shown in the accompanying engraving. If the grip should break or fail to attach, or if either of these should happen, the car or train would simply roll back to the bottom of the incline, and passengers could walk up to the next station,—all



without danger, as no other train could get on the block during the delay.

In the essential matter of cost, such a system has everything to commend it. There would be no disturbance of vested interests or property rights, and hence no outlay for costly terminals. The short cable systems at either end would involve a less expenditure than for separate engines or motors for each of the necessary number of trains. It would be a simple tunnel, the cost of which can be accurately measured by the outlay for corresponding work ; and in the aggregate *the expenditure would be less than one-third that for the Brooklyn bridge.* And as compared with that bridge the capacity would be as great or greater, while the operating expenses

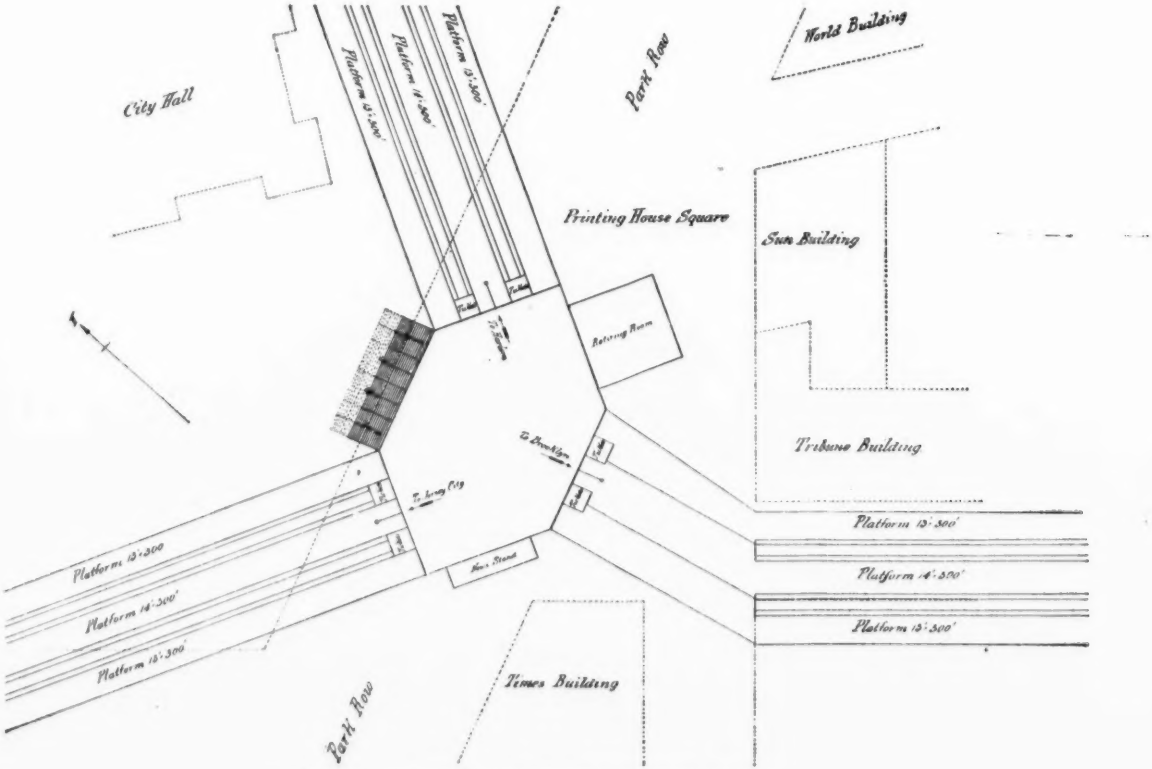
would be so low as to yield a relatively enormous profit on the small investment necessary. Moreover, the tunnel can be completed in two years, where it would require ten to build a bridge.

As to the theoretical objection to underground travel, that will be speedily dissipated in the mind of the man who finds that he can be carried from the City Hall in New York to the City Hall in Brooklyn *in less than half the time now required to cross the Brooklyn bridge alone.* But the details are too numerous for my space. It suffices to say it that meets the approval of such men as George S. Morrison, General William Sooysmith and other eminent engineers, one of whom has said :

> The more one considers it the more the apparent difficulties disappear and many minor advantages present themselves ; among others, I consider the factor of safety the most important, as the chance of accident will be reduced to the minimum. I should say that it would not be greater than one to twenty of the accident chance on the elevated roads, and one to fifteen of that of the Brooklyn bridge. It will have the advantage of perfect cleanliness, of being cool in summer, and warm and free from snow and ice in winter ; nor would it be disturbed by fires along the line, as is liable to occur on the elevated roads ; it will be lighted by electricity. It presents an advantage in economy of operation, the per cent. of expense to earning capacity being remarkably small. The two inclines provide for acquiring maximum speed in shortest time, and the opposite incline not only stops trains in the shortest distance, but affords a positively safe brake that makes it impossible for trains to get beyond control.

As the Brooklyn bridge has been unable to earn any considerable return on its great cost, it is hardly probable that private capital can be found to construct any more bridges, nor is it at all likely that either New York or Brooklyn will build them. Enough has been said to demonstrate that we have here an ideal system of rapid transit for handling the great crowds of people who come to New York on business, and who return to Brooklyn to their homes.

This being true, the inquiry at once presents itself : Why is not the same system applicable to all centers of population, where the requirements are similar to those here cited ? I confidently answer that it is a system which is certain to meet the requirements wherever an overhead system is inadequate, or where an underground system is demanded ; and I freely maintain that this simple and inexpensive little underground railway between Brooklyn and New York is yet destined to serve as a great object lesson to all the civilized world, as the one means for the solution of all the difficulties which surround the rapid transit problem in great centers of population. There are now a score of cities where it can be



PROPOSED UNION STATION UNDER PRINTING-HOUSE SQUARE, NEW YORK.

Station platforms only 16 feet below surface of street, and reached by wide and easy stairways. Capacity, 34,000 per hour to Harlem and Mott Haven : 15,200 to Brooklyn and Jersey City.]

applied, but let us take for example New York, where the problem in its most aggravated form is now presented.

Between the City Hall and Fourteenth street there is far more travel and greater need for quick transit than between Brooklyn and New York. In like manner there is an enormous traffic between Forty-second and Twenty-third streets and the City Hall; and an equally urgent demand for rapid transit between the upper or residence portions of Manhattan Island and the retail districts lying about Madison square. If it is practicable and profitable, alike to investors and users, to put such a road in operation between Brooklyn and New York, it is equally desirable to put in a succession of such roads the entire length of Manhattan Island.

Against such a scheme there lies the fundamental objection to an underground system, and the decided advantages which are offered by the overhead plan, giving light, sunshine, and pure air. But it must not be forgotten that people travel from necessity, not for pleasure; and in New York, more than anywhere else in the world, high value is placed upon minutes of time. The man who can travel from Fourteenth street to the City Hall in five minutes, as against ten minutes or more by the elevated or surface lines, will not hesitate long between the two. He is certain to go by that route which will take him quickest. More than this, the elevated system is now working to the full limit of its capacity, and, after every possible extension of it has been granted and is in perfect operation, it will be still overcrowded. *There is more traffic here than it can possibly handle, and every year brings an increase.* Indeed, Mr. Louis Heilprin, in a most excellent article in THE ENGINEERING MAGAZINE for July last, has demonstrated clearly that every scheme in relation to an extension of the elevated system shows a glaring deficiency in its capacity to handle the traffic which is here now and certain to follow. In a word, there is room for all the extensions of the elevated road that can be reasonably granted or desired, and, beyond that, there is the imperative need for greater capacity and a yet faster system. No one questions the ability of the elevated trains to make fast time. If permitted to do so, they could run between the Battery and Harlem, without stops, at the rate of fifty miles an hour—just as could undoubtedly have been done on the enormously expensive underground system proposed by the rapid transit commission. But this is not the point. What is demanded is not a system of fast trains between the Battery and Harlem, for there would not be traffic enough to warrant one-tenth

the cost of such a system; but there is a demand for such rapid transit as will enable a passenger to start, not at the Battery, or Rector street, or Cortlandt street, or City Hall, and get off at a particular station away up town, but a means of quick transit whereby a passenger can *get on near where he happens to be and get off where he desires*, be it anywhere from Forty-second street to Harlem. The underground gravity system is the only one that can possibly render such a service, for by the assistance of gravity a maximum speed is acquired in the shortest possible time with the least expenditure of power, and the opposite incline not only stops the train in the shortest possible distance, but affords a safe brake, thus making it impossible for trains to get beyond control. And it possesses the further advantage of a deep tunnel between stations, where it can do no injury to property on the surface, while, by rising near the surface at the stations, it dispenses with the cumbersome and impracticable scheme of passenger-elevators to convey people to the deep tunnels that have been heretofore discussed.

Then as to cost. The cry of rapid transit seems to have assumed a sort of craze in New York. Each one is trying to excel his neighbor in the grandeur and magnitude of his scheme, irrespective of possible success, and at times without regard to common sense. Just look at this picture! We have the plan of the Rapid Transit Commission, calling for a probable investment of from ninety to one hundred millions of dollars; the Green bridge over the Hudson to cost from fifty to seventy-five millions; and the proposed bridges over the East river for twenty-five millions, a stupendous total of from one hundred and sixty-five to two hundred millions of dollars. And for what purpose?

Now, as compared with these figures the cost of such a system as is here proposed would be simply insignificant. Every engineer knows the cost per running foot for building a standard tunnel, and beyond this we have only the cost of cars and the small cable power-plants that would be required at each station. I do not hesitate to say that the outlay necessary for a single new bridge across the East river, of sufficient capacity to meet the requirements, would build the New York system entire, from the City Hall to Mott Haven, and with it an arm from the City Hall to Jersey City, connecting with all the suburban and Western railroads terminating there, and thus removing the necessity for the Hudson-river bridge. This would give us a grand Union station just beneath the surface of the City Hall park, as shown in the engraving,

from which a man could depart for either Jersey City, Brooklyn, or up-town, and be landed at his destination with the greatest possible degree of safety and in the shortest conceivable time. Such a grand complementary underground system, supplemented by that extension of the elevated roads which every dictate of common sense demands, would, with the surface lines, give the metropolis every facility for handling, in comfort, the enormous aggregates that are now being added every year to her busy population. And a most important consideration is the fact that *this entire work could be accomplished within one to two years' time*, as can be readily demonstrated. The longest distance between any two stations would be 2112 feet. This would control the time required to build the entire work, because building could progress each way from all stations at the same time. Consequently, the greatest distance to tunnel from any one heading would be 1056 feet. Allowing for a progress of only four feet every 24 hours, and working three 8-hour shifts, it would require 264 days to complete the New York system, work going on continuously.

But would this give real rapid transit to the upper parts of the city? Let us see. It now takes about fifty minutes to make the trip on the elevated between the City Hall and Mott Haven. It should be done in about twenty-five minutes. The distance is $7\frac{8}{3}$ miles, and the number of stops should be twenty-three altogether, making an average of three to a mile. Averaging the time for stops at fifteen seconds, we have a total of 5 minutes and 45 seconds for all stations. On an incline of 10 per cent. descending 100 feet, with supplementary cable running at the rate of 15 miles per hour, the running time between stations (1760 feet) would be about 42 seconds, making 16 minutes and 6 seconds of running time, or a total of 21 minutes and 51 seconds for the trip. The only other important factor to consider is the maximum rate of speed acquired, which should not be so fast as to be alarming, and which, on the above basis, is only 52 miles per hour at the maximum. As it would be on a perfectly straight track, built in the most substantial manner, with high rails and deep flanges to wheels, and with a system of guard supports under sills of the cars, it is evident that this is not too fast.

In considering a system of rapid transit for New York due regard should be had for the future growth of the city, and the probable extension of population. It is not that part of New York situated above the Harlem river alone that we should consider, for, if we are

to have the Metropolitan city that we all expect, it must include Brooklyn and all the suburban population that now centers in Jersey City. It is obvious then that the necessities require trunk lines from the Harlem river to the City Hall and from Brooklyn and Jersey City to the City Hall. We must also take into account business centers or centers of population already fixed and determined. For New York the business center can be safely located at the Post-office, with residence centers of population in different directions ; and hence it would seem that the limit of necessity is regulated by the extent of accommodation in the vicinity of the Post-office. Under the old style of four- and five-story buildings, such as existed a few years ago, the total passenger traffic of the city was about 324,000,000, while in 1891 it was 404,000,000, an increase of 80,000,000, of which 76,000,000 was on the elevated and 4,000,000 on the surface lines. The surface lines represent the old condition of things, while the elevated lines reflect the influence of greater facilities, and the concentration of traffic at the central point. Is it not possible that the creation of business space in these tall buildings at the business center is the next great factor to convenience of transit in calculating future increase? The creation of greater business facilities by increasing the height of business buildings has already affected the volume of traffic to a considerable extent, as is shown by the increase of 70,000,000 of annual traffic on the elevated lines within five years. And the increase of central facilities has probably gone along about as fast as necessity demands. It can be reasonably estimated, therefore, that a similar increase will take place during the next five years, provided the transit facilities are made adequate to such increase.

Not counting the surface lines, which can undoubtedly take care of a greater increase than is likely to accrue to them, the question narrows itself to the ability of the elevated lines to accommodate an increase of 70,000,000 passengers within the next five years. This means nearly 200,000 per day, or 20,000 per hour for ten hours. Such imaginary conditions transport us to the regions of the impossible. The congestion recurs at only certain hours of the day, and always in the same places—down town. We must have relief at the most central point of congestion—the Post-office. Considering the insurmountable obstacles in that vicinity to surface facilities, tunneling is the cheapest conceivable means of relief, —and gravity is the only known and controllable force that can give us the high rate of speed necessary in such short distances.

PROGRESS IN STEAM ENGINEERING.

By Robert H. Thurston, LL. D.,

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I.—EVOLUTION OF TYPICAL FORMS.

THE progress of the century, of a generation, indeed, in the improvement and in the applications of the steam-engine are among the most notable of all the wonderful developments of modern times. It has been the basis upon which has been founded a very large part, if not the whole, of our present prosperity and material wealth; while the moral and intellectual advancement of the race has been hardly less a resultant of the thousand favorable conditions introduced by the employment of this mighty power. A hundred years ago James Watt was struggling to bring into a reluctant market his "newly improved and patent steam-engine." The machine had been known in crude forms for at least two thousand years, but the steam-turbine of Hero (120 B. C.), his steam-fountain, and his many other steam-apparatus, so far as we are aware, were only toys and were never given any really useful application; notwithstanding the facts that the former was a germ of the modern illustrations of that class, a more nearly ideal form of the engine than even the most perfect of modern machines, and that the steam-fountain was a prototype of all later applications of steam-machinery up to the time when Newcomen—the inventor of the modern steam-engine—produced the train of mechanism which constituted the foundation upon which Watt and Sickels and Corliss and Green and all later inventors have, for so many years, been building. For twenty centuries the steam-turbine lay concealed amid the wreck of Grecian civilization, and the steam-fountain remained but a curious plaything all through the middle ages; the highest task of either being the turning of a spit at the kitchen fire. For two centuries after Porta and Branca and De Caus (1601-1620) revived this steam-fountain, the world still profited nothing by its dormant strength. A century elapsed after Savery made his first really business-like attempt to bring it into operation as a mining pump (1669), and after Newcomen brought forward his grandest of all the whole line of improvements, before the genius and persistence of Watt and the intelligent liberality of

his partner, Boulton, had fairly given the reawakened mist-giant his opportunity and assigned him his task. But, from that time, the progress of improvement of the machine and the corresponding advances of the world in all that constitutes real prosperity have been rapid and as continuously accelerated as the fall of a meteorite from the heavens.

Newcomen (1705) gave us the first real steam-engine, a machine embodying the essential elements of the modern pumping engine: boiler, steam-cylinder, transmission mechanism, and pump. Watt (1763) introduced the separate condenser and the whole list of minor parts of the modern engine, and showed us how to effect improvement in its economical operation by the expansion of steam. Sickels (1841) applied to the valve-gear the first successful trip-motion, and gave us a system of cut-off apparatus which permitted Watt's idea to be carried into effect to any desired extent. Zachariah Allen (1834) showed us that the attachment of the governor to determine the degree of expansion is an element of efficiency. George H. Corliss (1849) gave us a new engine, a distinct and original type, in which were embodied the idea of Watt, the system of Allen, the principle of Sickels, and a design and construction wholly his own. Green (1855) designed a machine in which all these main principles were illustrated, but in a type of valve-gear essentially different from those of all other modern machines,—the "plug-tree" form of valve-motion. Wright (1855) and many others brought out still other forms of engines, each in its way interesting and useful, until the middle of the nineteenth century saw the steam-engine practically completed, so far as its essential elements were concerned.

Even the "compound engine" was invented almost a century ago,—by Hornblower,—and was said by Watt to be simply a too precipitate introduction of his own invention of the same kind. It was gradually perfected for marine purposes by Randolph & Elder, the great Scotch firm which has come to be, to-day, the Fairfield Works, and the builders of the *Lucania* and the *Campania*, the Cunard steamers now representing the most wonderful products of the genius of man, applied to ocean navigation. The locomotive grew into form during the first quarter of the century; and the steamboat was in existence as long before the commercial success of Fulton proved to the world that it had come into permanent use.

Recent and contemporary progress has thus been in the refine-

ment and adaptation of the machine to special purposes, rather than in the introduction of new inventions or the addition of new improvements upon the old ones. The steam-boiler has been given new forms to adapt it to new purposes and new locations, and to make it more economical of fuel; the engine has been gradually given certain special and typical forms to better adapt it to special kinds of work, and this specialization has gone on to a most remarkable extent. To-day the railroads of the country have at least three principal types of engine locomotive for heavy-freight, for fast-passenger, and for mixed traffic, while the varieties in each division are as numerous as are the kinds of work required by the roads: some hauling enormous trains at low speeds through a level country; some pulling trains up gradients of 100 to 200 feet to the mile; others hauling "express" trains four hundred miles at the rate of fifty and sixty, sometimes eighty, miles an hour, for short runs; still others, small but active, loaded up with their own water and fuel, "switching" cars and trains about the terminal yards and stations with a power and venomous alacrity which would make our grandparents look upon them as the most uncanny forms of the mist-giant. Special types are even built for use in the yards and buildings of ironworks and in the interiors of mines. Similarly, the modern marine engine takes protean forms and applies its mysterious and tremendous power to the turning of a screw, the driving of a paddle-wheel, or the operation of a water-jet; sometimes in the well-lighted engine-room of the 10,000-ton ocean "racer"; sometimes in the depths of the hold of a vessel-of-war; often on the deck of a river steamer; occasionally concealed within the narrow bounds of the submarine or surface torpedo-boat. In the less impressive field of stationary engineering it here drives the 150,000 spindles of a cotton mill; it there turns the swift armature of the dynamo; the one revolving its shaft with a deliberation and force that impress the beholder as if he were gazing upon limitless power, the other working away with a feverish haste that seems an attempt to overtake its own product, the lightnings streaming off to give light and power over miles of adjacent country.

The progress effected during the history of the modern steam-engine has been in three principal lines: (1) increase of thermodynamic efficiency, in the completeness with which the heat-energy supplied from the boiler is converted into dynamic energy by the engine; (2) decrease of thermal wastes, internal and external; (3)

reduction of dynamic, or mechanical, wastes of the dynamic energy thus obtained; and (4) concentration of power within reduced limits of volume, weight, and cost.

Of these several methods of promoting the economy and handiness of the machine, the first has been made effective by (1) the steady increase of pressure made possible by improved constructions of boiler and (2) the increased range of expansion and of thermodynamic transformation of energy thus made practicable. The second has come of improved methods of covering the exterior of the boiler, the steam-pipe, and the engine-cylinder with non-conductors, intercepting effectually the heat which would otherwise be conducted and radiated to surrounding cooler objects, and thus wasted externally; while at the same time, internal wastes—which occur in very large amounts by the alternate abstraction of heat by the comparatively cold metal of the cylinder, when the hot steam enters, at the opening of the steam-valve, and its later rejection when with progressing expansion the steam, in turn, becomes cooler than the iron—have been lessened by better construction, permitting a smaller area of wasting surface to thus reduce economy, and by that increased speed of piston and of rotation of the engine which has been one of the most striking changes noted during this period, and also by the more effective jacketing of the engine, by superheating, and especially by "compounding." The third gain has been made by increasing the power of the engine as a function of its weight, and especially by improved workmanship and better methods of lubrication; for this dynamic waste is purely friction, the only possible source of lost work in any permanently operative machine. The fourth of these great advances, concentration of power, has come of the steady and lately rapid progress made in securing safe operation of the engine at high speeds; while some advantage has come of the simultaneous improvement in proportioning parts and in the use of stronger materials, as in the substitution of forged steel for wrought iron, in the running parts, and of steel castings and the better classes of new bronze and brass alloys for cast iron, in the frame and attached parts; and, again, through the enhanced pressures and lessened wastes of power already referred to.

All these improvements have been the result of the application to their promotion of more mechanical genius, higher skill, more careful and scientific research, more brain-power generally, than probably have ever been given, in the history of the world, to any

other directly useful purpose. The steam-engine stands, to-day, as a nobler monument, a higher tribute, to the genius of man, than any other product of his many and mighty powers that the world has yet seen. It is the source and the foundation of all his material wealth and largely of his intellectual and moral wealth. It is the prime mover in every application of his inventive and constructive genius to the solution of the problems of modern civilization. It drives the machinery of mine, mill, and workshop; it transports him and his possessions across the continents and over the seas; it gives life to the whole system of transmission of all the energies, including those of the electric light and the electric railway. It makes all that he has and is a possibility, and stands, the mist-giant, a genius of more than Aladdin-like power, the maker and the guardian of modern life. Light, heat, and electricity, all the powers of nature, are but its servants and do its work and run its errands, at arm's length or miles away, in the extension of its powers to near and distant fields of labor alike.

In performing the work of modern civilization man has compelled the service of over 50,000,000 horse-power of steam-giants, equivalent to more than 75,000,000 horses of average power, for the rated horse-power of the steam-engine is to that extent in excess of the power of the animal. This is the equivalent of the steady working power of the whole population of the globe, and probably largely in excess of that amount.

In the progress which has thus marked the introduction, in a century, of more wonders into human life than had the thousands of years preceding, the engineer has pursued the directions of development already specified, and has gradually increased the working pressure at the boiler from the barely more than atmospheric weight of the time of Newcomen, the three to seven pounds of Watt, up to 100 pounds as a not unusual minimum, to 150 pounds with many locomotives and marine engines, and to 200 pounds for the latest and most radical practice; while even in the times of Stevens, Perkins, Albans, and later experimentalists, pressures were employed, in some cases, attaining 500 to 800 pounds, and, for Perkins's work, including his steam-gun, 1500 to 2000 pounds on the square inch were safely passed. Messrs A. M. Perkins & Sons, of London, sons of the American inventor, for many years have built engines, regularly, to work under pressures exceeding twenty atmospheres. Following Stevens, who first built tubular boilers,—and who first enunciated the principle (in 1804) that "to insure safety, boilers

must be so made that their explosion will not be dangerous,"—comparatively safe forms of these boilers—"safety boilers" so called—have come into extensive use, and the makers of "shell boilers" have learned to make them as exactly suited to their work and as safe as all the arts of the modern machine-shop, reinforcing the methods of the boiler-shop, can make them; and that is sufficiently near absolute safety to make the insurance upon them a small matter. For stationary engines the "sectional" boiler is rapidly coming into general use. It has been less successful at sea; but French builders have had such boilers in use for many years, on a great variety of vessels, and with, apparently, good results. The indications are that it will not be long before a pressure of 200 pounds will be a common one wherever great economy is sought and the multiple-expansion engine is adopted to secure it. The higher the pressure, the more anxious is the engineer to insure safety against explosion and in case of explosion, and the more does the safer, but often in some respects less satisfactory, boiler come into view as the final resort. For torpedo-boat service, particularly, this change is already effected, and the revolution seems likely to extend to larger vessels, as well as in applications on shore, at an early date, notwithstanding occasional failures.

Economy was shown by Watt to be largely dependent upon the extent to which expansion can be practically employed in the steam-engine; and following his lead, and as higher pressures have made such gain possible, the cut-off mechanism has been gradually readjusted to give a ratio of expansion rising from two at the beginning of the century, to three, four, five, and eight, in non-condensing engines driven by steam of 60, 80, 100, and of 150 pounds pressure; and this has been increased to ten and fifteen with condensing compound engines, to twenty with triple-expansion, and it may be assumed that not less than twenty-five will be taken as a minimum for quadruple-expansion engines, with their boilers supplying steam at two hundred pounds and upward. A terminal pressure, in the latter classes of engine, of from six to ten pounds above a vacuum, in the most economical machines, has been commonly the limiting element for extreme expansion; while a tendency exists to gradually, but more slowly, raise the back-pressure in the condenser to meet the former, and to force the minimum limit of temperature upward, at that point, toward that due the atmospheric pressure of exhaust steam, as the boiler pressure rises. This simultaneous increase of pressure, of expansion-ratio, and of

range of temperature worked through, has given but a part, however, of the noted gain, effected since the time of Watt.

The resultant thermodynamic improvement, the increased proportion of the heat supplied which is converted into dynamical or mechanical power by the engine, has been very great; but the defects of the older machine were no less in their enormous extra-thermodynamic wastes of heat and of power than in their faulty thermodynamic adjustments for utilization of energy by its conversion from the thermal to the dynamic form. The two great methods of advancing the economical value of the machine have thus been, at all times, as they must always be: first, the improvement of the thermodynamic action of the engine, increasing the proportion of heat transformed into work, and reducing correspondingly the distinctively thermodynamic wastes; secondly, the extinction more and more completely of the thermal and dynamic wastes of the machine which are consequent upon its imperfections of design and construction, and the reduction of the losses of heat by conduction and radiation and of power through friction. All improvements in the engine which have promoted its economy have come of one or the other of these two lines of progress; the latter has been the most important of the two in the past, and is not unlikely to be the most important in the immediate future. The amount of these wastes is to-day well understood, and can be easily computed for any given case; and the engineer can to-day, as never before, readily determine just to what extent and in what direction he must seek to advance. His path is charted for him with precision.

THE GOLD-FIELDS OF DUTCH GUIANA.

By A. I. Mather.

THE voyages of Sir Walter Raleigh in quest of the El Dorado which early Spanish explorers had reported to exist somewhere in South America were a failure so far as the direct object of his search was concerned. But he did find abundant evidences of vast gold-fields, which, for the greater part, remain unexplored to this day. The writers of his day, beyond doubt, located "El Dorado" in the interior of the Guianas, a country embracing what are known now as English, Dutch, and French Guiana, and a portion of northern Brazil, all laid down in old charts as "Portuguese Guyana." It is of the gold-fields of Dutch Guiana, or Surinam, that this paper will treat.

Surinam lies on the northern coast of South America, between Demerara, or British Guiana, and Cayenne, or French Guiana, Brazil forming its southern boundary. Surinam has been in the possession of the Dutch since 1667, previous to which the Spanish, Portuguese, English, and others had held desultory possession. In 1667 a Dutch fleet of three vessels, commanded by Admiral Crys-sen, ascended the Surinam river to the English settlement, captured the fort, and received the capitulation of the colonists. Meanwhile England had conquered from the Dutch their colony of New Amsterdam in America (now the State of New York), and by a treaty with Holland in the same year it was agreed that each power should retain the conquests made. Surinam was ceded to Holland in perpetuity; and New Amsterdam in like manner became the property of England.

Surinam has a sea-coast of about 220 miles, flat and low, and is of alluvial formation. Approaching it from the sea, no hills or prominences are seen. The alluvial formation is continually increasing by sediment deposited by the large rivers from the interior, which have their rise among the high gold hills and run in a northwardly course into the Atlantic. The colony contains more than 58,000 square miles. The capital is Paramaribo, the principal town, and, one might say, the only one in the colony. It has some 30,000 inhabitants, or about half the entire population of the colony. Situated upon the Surinam river, about ten miles inland, it presents

BUSH NEGROES IN DUTCH GUIANA.

the appearance of a Dutch town, with its gables, tiled roofs, and open dikes. The population is composed largely of negroes, Chinese, and coolies, with a small percentage of white Dutch. A few Americans and English are also established there. Paramaribo has natural sanitary conditions. It is built upon a shell formation, with an unusually porous soil, and draining into open dikes or canals, which are run dry every tide, and filled afresh with the inflowing of high water. This accounts probably for its exceeding healthfulness, compared with other tropical ports. The reports of the government medical bureau for the ten years from 1880 to 1890 show a death-rate ranging from 2.43 to 3.80 in 100. Contagious diseases are almost unknown. Though Demerara and Cayenne are known to be unhealthy, nature seems to have done everything to make Surinam a healthful locality.

Some forty or fifty miles up-river from the coast the land begins to show a higher elevation. The luxuriant growth of tropical

vegetation prevents a landing, except where places have been cut down and cleared for this purpose. The auriferous belt is about seventy-five miles in a straight line south from the sea-coast. It runs through the colony in a northeast and southwest direction, and also extends through Cayenne, Demerara, and Venezuela. It is from 75 to 100 miles in width, and thus far has not been half prospected. Its geological formation is highly metamorphosed, consisting of porphyry, granite, schist, and obsidian. It belongs to the Silurian period. There is an abundance of iron conglomerate, with brown and red hematite. The reddish soil shows a composition of the detritus of iron and quartz. The country is mostly one wild tangled mass of verdure. There are high mountains, which

SLUICE—UPPER SARAMACCA MINES.

LABOKERS' HOUSES—UPPER SARAMACCA.

in nearly all cases are covered with heavy timber, with occasional open savannahs. Quartz is not easily found, owing to the extreme fertility of the soil, the vegetable products of which bury everything from sight, under a robe of green. Still, disintegrated quartz is freely found in creeks, and at the heads of these tributaries large pieces of quartz are found, and nuggets of gold, some surprisingly large. In the extreme dry season regular veins of quartz may be seen, crossing the rivers diagonally. No attention has been paid to quartz-mining, the alluvial washings paying well enough to satisfy all engaged. Beneath the gravel of the numerous creeks is found generally a hard yellow clay, and sometimes a bluish-white, changing downward to a soft slate. That a rich deposit of precious minerals is contained in this belt of country no one can doubt who has seen it. In the belief of more than one expert who has reported upon this subject, the Guiana district is destined to become the greatest gold-field in the world. All mining heretofore done has been of the most crude and primitive order, being

confined strictly to alluvial washings, with sluices and long toms, and mining may still be said to be in its infancy. Until quite recently no mining machinery of any sort has been used. The crude methods have been most prolific, and persons unacquainted with modern modes of mining have realized large fortunes, notwithstanding the great amount of stealings by employés. Most of the property-owners are satisfied with the products rendered, without the trouble to superintend their mines personally. Cases often occur where the laborers profit more than the employers. There is a lamentable lack of experienced miners, though a few Americans have been successful by working understandingly.

The question will naturally arise why so much mineral wealth has been allowed to remain so long comparatively unknown. This can be easily answered. The exaggerated stories of travelers, who picture this country as a death-trap, and who paint the horrors of bush-life with a master hand, are alone sufficient to deter the aver-

MANAGER'S AND OVERSEER'S HOUSES—UPPER SARAMACCA.

age explorer. Again, the mining laws permit any individual to secure unlimited territory, merely by the payment of a small tax, and to hold the same as long as the tax is paid. When gold was first discovered, large grants of land were taken, and, since all finds belong to lessees of land under the mining laws, prospectors can file no claim for rich finds. The lack of persistent application, characteristic of these people, has also tended to prevent the development of mining. So far as health is concerned, a person with

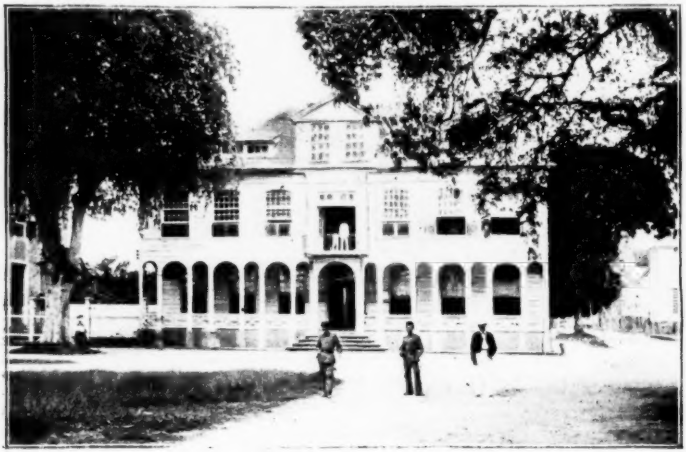
THE CANAL—SARAMACCA RIVER.

a good constitution, by careful attention to diet and cleanliness, with a proper regard for hygienic conditions, will be able to live comfortably in this climate. A prolonged residence in the bush is liable to develop malaria, which is dissipated by a change to a colder climate. The days are quite hot, the thermometer registering on an average 85°. The nights are cool, however, and in the bush blankets are indispensable. There are two seasons, the rainy and the dry.

Concerning the richness of the gold deposits, I can state a few facts which have come under my personal observation. A placer containing some 35,000 acres is owned and managed by an American syndicate, who have been the first to introduce machinery for mining. They have just set up a steam dredge and amalgamator, and have a stamp-mill ready for working when quartz reef is sufficiently developed. This property, which has been worked continuously since 1879, was purchased by the syndicate in 1892. This mine has produced as high as $85,000 in one year, worked in the slipshod way peculiar to this country. At the time of sale it was paying its owner a net profit of $3000 per month, with forty laborers employed. The mining already done had been so poorly performed that second and third washings have since paid handsomely. The place may be said not to have been prospected for more than one-tenth of its area, and it will require a whole year to make a thorough prospect. In one flat, 500 to 1000 feet wide, with from 6 to 10 feet of stripping, there is a pay streak of gravel, varying in depth from 5 to 10 feet. Mining experts have conservatively estimated a pay streak over 500 feet wide, containing more than a half-million cubic yards, easily paying $5 per cubic yard. On a creek, 2000 feet of which has been worked over twice, is a high bar 1000 feet long, where six feet of stripping uncovers three feet of gravel carrying $3 per cubic yard. This bar is on the hillside. Another creek empties into a swamp with an area of nearly one-fourth of a square mile, and has a deposit of 1,500,000 cubic yards, a low estimate of which gives from 25 cents to $1 per cubic yard. One creek has at its head three feet of sharp quartz gravel, pans showing $20 per cubic yard. Another bar of gravel, some 40 feet above the creek, has 12 feet of pay dirt, 60 yards wide, pans showing $6 per cubic yard. Part of this bar has a layer or capping of ironstone some 2½ feet thick. Sixteen thousand cubic yards were estimated, and, had facilities for blasting been at hand, no doubt this bar would have been found to contain 1,000,000 cubic yards, according to an expert estimate. Another creek showed 6000 cubic yards at $10 per yard. The pans averaged as follows per cubic yard: lowest (from top dirt), 17 cents; highest, $467.25. A most conservative estimate was $5 per cubic yard.

At the time of the purchase the cost of working a sluice of eight men was about $8 per day. Each cubic yard cost $1.50 to be mined, and netted its owners, as above stated, $3000 per month. Improved methods of hand-working have lessened the cost of pro-

duction one-half. With hydraulic working the dirt can be readily handled for less than 15 cents per cubic yard. Compare cost and product of hydraulic mining in California with possibilities in Surinam! According to a report of hydraulic working of thirty-three California mines, the yield averaged a trifle less than 12 cents per cubic yard, while 39 smaller mines, worked by the same system, averaged less than 3 cents. The highest average above came from a small bar, less than 1500 yards, yielding $16.50 per cubic yard. Then compare the difference of fineness of the gold. The best authorities state that the average fineness of California gold is from 880 to 885 parts in a thousand. Twenty-five samples from different localities in Surinam, given to a United States assayer,

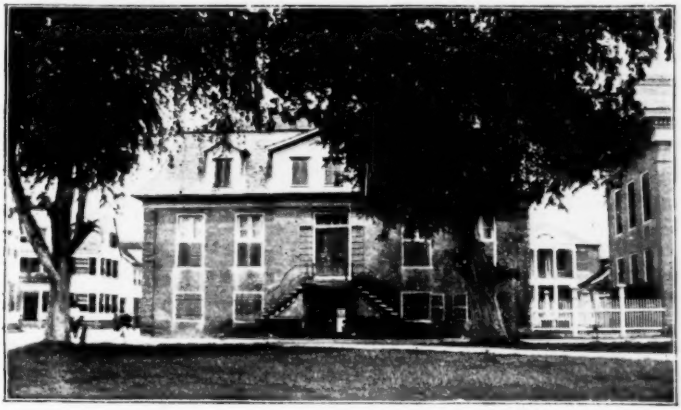


GOVERNMENT BUILDING—SURINAM.

showed the fineness of the gold to be 961 gold, and 34 silver, or, 995 parts of precious metal in a thousand. This extra percentage of value, it is claimed, is sufficient to cover all mining expenses.

The possibilities in Surinam for placer and quartz mining are unlimited. It is my firm belief that there are spots yet unexplored that will range far ahead of any now known. But without American push and capital success cannot be hoped for. The government has done practically nothing towards opening up and developing the interior of the colony. A good railway system is needed to reach the far interior. Without doubt concessions of valuable lands on each side of a proposed route could be obtained from the

government. There is an unequalled opening for the utilization of electrical power in mining in these vast regions. Placers can easily and cheaply be mined by means of the systematic use of dredging-machines. With pumping plants to furnish water to sluices, many of the low flats now inaccessible for hydraulic nozzles could be mined, under the most unfavorable conditions, for less than 15 cents per cubic yard. A railroad, in addition to promoting the development of mining, would greatly facilitate the shipment of the numerous fancy woods for cabinet-work. With their aid abandoned sugar-, coffee-, and cocoa-plantations, that may now be purchased at merely nominal prices, might again be revived. The cultivation of the banana could be started there more cheaply than in any other tropical part. The present governor is in favor



COURT HOUSE AT SURINAM.

of a progressive policy, and will welcome foreign capital legitimately applied. Investments are safe ; the colony has no debts, all deficits in the revenue being met from the treasury of the home government in Holland.

All the highways leading to the gold bush are water-routes. The means of travel are river steamers of light draft, native boats, and "dugouts." Steamers are not able to proceed up most of the rivers beyond 100 to 150 miles, on account of the rapids and waterfalls, all of which are gotten over safely in small boats, by aid of native bush-negroes, who are expert navigators in these wild waters. The nearest placers are about two days from town by steamers,

POLICE STATION AT SURINAM.

and from five to seven in row-boats. Some placers in the upper Sara creek are nearly twenty days distant, owing to the great number of waterfalls to be passed. All provisions, tools, and laborers are transported in this manner. Provisions are packed usually in small boxes or tins of about fifty pounds each, to facilitate carriage from the water-side into the mines. A laborer will easily carry one of these boxes on his head a whole day. All the large mining concessionaires have magazines on the water-side, where provisions are stored, to be conveyed to the placers as required. These are usually taken up into the bush in the rainy season, when the water is high in all the creeks and rivers, for in the dry season navigation is somewhat disturbed by the uncovering of rocks and sand-bars which are invisible in the rainy season. Provisions of all kinds are easily obtainable in Paramaribo at fair prices. American beef, pork, flour, and other staples can be purchased there as cheaply as one could import them.

The laborers employed in the mines are the native negroes. Usually lazy, they have to be sharply looked after. The overseers are generally the better class of negroes, half-breeds, and some whites. The wages paid to laborers are from 40 to 50 cents per day, while overseers receive from $20 to $40 per month. These figures represent United States currency values, as the American

cent is equivalent to 2½ Dutch cents. Laborers are supplied with food by the contractors from the time they embark for the mines until they return to town. If they are sick or unable to work, they receive no pay, but are entitled to their rations, which for one week are as follows:

6 pounds rice.	1 pound salt pork.
2 pounds flour.	1 pound salt beef.
1 pound split peas.	1 pint molasses.
1½ pounds salt fish.	3 leaves tobacco.

A supply of medicine is required to be kept on the plains for use of the laborers. The overseers receive a higher grade of fare, and usually mess among themselves, or with the manager. One dollar per day for each man is reckoned sufficient to pay for all labor, provisions, tools, transportation, overseer's salary, and all incidental expenses in mining gold.

The governor of Surinam grants concessions to any one for a term of not less than one, or more than forty years. The lease of the concession can be renewed on expiration. Land is measured in hectares, a hectare being 2.4711 English acres. Any party desiring to prospect government lands files an application for a certain tract, which must contain not more than 50,000 acres, to be selected from the government chart. He is furnished with a duplicate copy of his map, and a lease of his possession for one year. For this there is a small fee. The annual tax on the land for the first year is 4 cents per hectare, for the second year the same, for the

POST-OFFICE AT SURINAM.

THE "PARK" CLUB—PARAMARIBO.

third and fourth years 10 cents per hectare, and for each ensuing year 20 cents, or, in round numbers, 8 cents per acre. The prospector is then allowed to work his grant. Proproprietors are required to make their contracts with laborers before the commissary of police. The government has established at convenient intervals on the rivers, between the town and gold-bush, police posts, where all laborers are required to register on going to and coming from the mines. No laborer is allowed to pass these posts going towards

CHINESE CLUE-HOUSE—PARAMARIBO.

town without a written permit from the manager. The government thus keeps track of all laborers, and the police are required to assist in hunting up runaways and returning them to the mines. Laborers are not allowed to carry fire-arms, but proper parties may obtain a permit to carry arms by a payment of $2 a year. The negroes are not generally vicious, and disturbances are exceedingly rare. It is somewhat surprising to know that the vast amount of gold brought down from the bush is virtually unguarded. I have known eighty pounds to be brought down in an open row-boat, in a rusty tin canister, fastened with a common padlock, all hands turning in to sleep nights, leaving the gold in charge of an overseer,

SURINAM BANK AT PARAMARIBO.

also asleep, armed only with an umbrella. I never heard of a case where gold was molested in transit.

The miner on government lands can transfer his concession to another, by getting written permission from the governor, who can then give him a new concession for the unexpired term of his original grant. All deeds transferring property are subject to a tax of 2 per cent. on the actual cash price. The government is not responsible for any errors on maps, or for disputes arising between neighboring concessionaries. Fortunately these are rare occurrences and are easily settled by employment of government surveyors or before the courts. Holders of mining lands can use all the timber desired for the prosecution of work, but are not allowed to market

any. Timber is found in abundance, embracing many valuable sorts of woods. There is water available for all practical purposes during the rainy season. By storage in dams for use during the dry time, mining can be carried on uninterruptedly throughout the year. The rainfall per year is about 7 feet. A fine is imposed for prospecting and mining without a permit. There is an export duty on gold of 5.38 per cent. and a considerable quantity is smuggled every year.

This territory is now awaiting the talismanic touch of American enterprise. Fortunes are buried amid these tropical wilds. Fame awaits the Stanleys of this "dark continent." Whence came those vast plates of beaten gold with which the ancient Indians adorned their persons, and which, they asserted, came from a mountain in the interior of the Guiana district? Who can tell what became of those people who fled before the rapacious brigands of the conqueror Pizzaro? An old legend states that a train of 10,000 llamas laden with gold to complete the ransom of the Inca of Peru was stopped in the Andes mountains by the intelligence received of his cruel death, and this enormous treasure has been so effectually concealed that not a trace of it has ever been found. Shall we view Raleigh's tale as a myth, or will the broad light of investigation some day prove that the half has never been told?

ICE-FACTORY AT SURINAM.

ENGLISH AND AMERICAN RAILWAYS.

A COMPARISON AND A CONTRAST.

By William M. Acworth.

SECOND PAPER.

WHEN I was in the city of Washington, I was told that, if any American citizen chose to go to the White House on a certain day of the week, he could walk in as a matter of course and shake hands with the president of the United States. To the mind of an Englishman, however fully prepared to accept the doctrine of the equality of all citizens from a political point of view, such democratic simplicity of habit is almost inconceivable. Americans, when they come over to England and find our trains divided up into innumerable small compartments of three different classes, are apt, I think, to forget that our trains are in the main intended for Englishmen, and that the national habits of our country are not those of America. With us it is practically impossible for a gentleman to travel side by side with his tailor; it is equally impossible for the tailor to travel with his own workmen. Though all the three would be made uncomfortable by the attempt, the workman would probably be more uncomfortable than his master, and the master than the customer. That these national sentiments and habits still exist and have to be reckoned with by the railway companies is as indubitable as is the fact that they are nothing like as strong as they were when railways were first introduced two generations back, when it was looked upon as positively discreditable for a gentleman to travel except first-class. The railways themselves have probably done more than any other single agency to break down these class barriers, and one evidence of their success is to be found in the fact that second-class carriages are rapidly dying out in England. In a few years' time we shall probably have only two classes on long-distance trains throughout the country. For suburban travel, however, the three classes will apparently be still maintained, for, though strangers of very different social rank can meet without difficulty, on local trains, where the passengers—many of them season-ticket holders—to a great extent know one another at least by sight, the division of classes still seems as necessary as ever.

But though we move slowly, yet we do move. The absence of lavatories from the trains has long been made a ground of complaint by American critics. Even when they were introduced, they were for a long time attached only to first-class carriages; but now main-line rolling stock is usually built with lavatory accommodation for third-class passengers as well. Within the last few weeks it has been announced that dining-cars for third-class passengers will be attached to the Scotch expresses by all three routes. It cannot be long before third-class dining-cars are followed by third-class sleepers. But innovations in the English railway world are always handicapped by the fact that our English system was complete in its main outlines fifty years ago; and that for many years past the additions have been of only trifling importance. Take such a question, for instance, as constructing passenger-cars sixty feet long, as in America, or thirty feet long, as with us. Every reasonable person must admit that for a train which is to run solid from, say, London to Glasgow, long carriages on what Americans call "trucks," and we call "bogies," are the best. But for English use they have great disadvantages, and their introduction is opposed to some of our most cherished customs. Most of our trains consist of carriages going to four or five different places, and are broken up and remarshalled two or three times on their journey. If there is not a through carriage from London to Blackburn, the Blackburn people will grumble. Yet to run a carriage weighing five-and-thirty tons for the benefit of possibly half a dozen Blackburn passengers is not to be thought of; and, if we are to have comparatively small vehicles on main-line trains, the others must be kept in some proportion to them. There was a pretty serious accident a short time back caused apparently by putting a small four-wheeled carriage in between two big modern ones.

Take the somewhat similar question of goods-trucks. Americans laugh at our tiny four-wheeled wagons; yet the introduction of their big cars would be almost impossible here except in very special cases. Almost every goods-shed in the country is worked with turn-tables; many of them, as has been said, move their trucks up and down on lifts, and neither turn table nor lift could possibly take in an American car. Then again goods go through, without transhipment as far as may be, from end to end of their journey, so as to avoid delay. Station A, if of any importance, can usually find a ton and a half or two tons of stuff to send to B; but the stations that exchange with one another enough commodi-

ties to fill a car the size of those in America every night could almost be counted on the fingers of one's two hands. It is said that such cars could at least be used for coal and iron ore, and so doubtless they might, could the coal-owners and mine-owners be induced to reconstruct their arrangements for loading; could the ironmasters be persuaded to remodel the access to their blast-furnaces, the dock companies be induced to provide new coal-lips, and so on.

Take another point on which the American practice and ours are entirely opposed. Your engineers believe in double-manning or even chain-ganging your engines; with us it is the usual custom —with passenger engines almost the universal custom—always to send an engine out with the same driver. One company, the London and Brighton, carries the principle so far that the name of the driver is painted up inside his engine, and underneath it the number of miles the engine has run between visits to the shops. No doubt our practice requires more engines; but, as I have said, capital is abundant, and there is no difficulty in supplying them, and our people are convinced of the compensating economy in fuel and repairs. In America you may like to wear out your engine in ten years, because in ten years your methods of business may be revolutionized, but our services go on with little change year after year. Until May last, when the broad gage was abandoned, the Great Western had engines running which were designed in 1846,—some of them indeed were constructed only a very few years later. The Northwestern still runs very fast expresses with engines of a pattern which came out in 1862. Why hurry an engine to the scrap-heap by overworking it when it is likely, if fairly treated, to do good work for twenty years longer? For that our engines can stand continuous hard work, if they are put to it, may be taken as proved by the performance of a Northwestern engine, the "Charles Dickens," which has beaten any record in the United States or elsewhere by running more than 100,000 miles per annum for the last eleven years with nothing but the most ordinary shop repairs.

It is evident, I think, that from an abstract point of view our locomotives are more efficient machines than yours. It has been demonstrated, I believe, that they do more work per pound of coal burnt. The explanation is obvious. The work which you give your engines to do is so heavy that, grate-area being limited, you are compelled to force the draught in order to develop the necessary power. In similar circumstances an Englishman divides his

train, and works both engines well within their capacity. This implies a larger capital investment in engines and the wages of four men instead of two, but in return there is considerable economy of fuel, and, while capital and wages are both much cheaper in England than in America, coal costs with us something not very far from double what it costs, at least in the middle States of America. Whether it be owing to the great economy as coal-burners of our ordinary engines, or not, I cannot say, but certainly the principle of compounding does not seem to be making much progress in England at the present moment, though one English builder at least has built a great many compound engines for export to foreign countries. Two of our great companies have gone in very largely for "compounds," but no other company seems inclined to follow them. The Northwestern, whose locomotive-superintendent is Mr. Webb, builds engines with three cylinders, two high-pressure outside cylinders exhausting into one low-pressure cylinder underneath the smoke-box. Mr. Wordsell, on the Northeastern, adopts the Wordsell and von Borries two-cylinder system.

Coming to smaller matters, the Americans are, I think, ahead of us in the matter of carriage-lighting. We have a good many trains lighted with electricity, a light which from the passengers' point of view leaves nothing to be desired. But it does not seem likely to come into general use, and will probably remain with us, as in America, a luxury and an advertisement for a few crack trains. Probably we have carried gas-lighting further than in America, so far at least as the proportion of stock goes to which it is applied; but our gas is usually so insufficient, either in quantity or in illuminating power, as to be almost entirely useless to read by for more than a few minutes consecutively. Why the tens of thousands of season-ticket holders around London have gone on year after year, contentedly submitting to sit idle for want of a decent light to read by, is a thing difficult to understand. And if we have suffered for lack of light, we have suffered even more for lack of heat. The Midland Company, the newspapers say, is experimenting with a system of steam-heating from the locomotive. Some company or other has been experimenting any time these past ten years, but meanwhile the passengers on all the companies' lines have merely shivered, and tripped getting in and out on the ridiculous old-fashioned hot-water tins. A stranger might ask why the Board of Trade does not interfere in matters such as these; but the Board of Trade, though it watches with motherly

or even grandmotherly solicitude over all questions of the public safety, has never concerned itself with questions of comfort.

Even in the matter of safety it cannot, I think, be said that the influence of the Board of Trade's action has been wholly beneficial We unquestionably have the best system of signaling in the world. The absolute block system is in force almost throughout the length and breadth of the country, and the New York railway commissioners are probably the only body of men in existence who conscientiously believe that any possible time system is as safe as one insisting on an absolute space interval. But having reached this point, we hardly seem likely to attain to anything better. A perfect automatic system should surely be safer than any system which depends on the agency of a signalman. But an automatic system introduced merely as a check on a full staff of ordinary signalmen is hardly worth the money it must cost. The Board of Trade, however, seem inclined to insist on the maintenance of the signalmen, and, as the companies are naturally not prepared to duplicate their service, the development of automatic blocking is making no progress whatever. This latter statement is, by the bye, not absolutely true ; for the Liverpool overhead line, which is to be opened directly and operated by electricity, for a service more like that of a tram than of a railway, is to be controlled by an electric block ; but in this case the conditions laid down by the Board of Trade were such that no steam railway could possibly have complied with them, for they required that, when certain draw-bridges were opened, the electric current should be automatically cut off from the sections of line on either side. The analogy in the case of a steam railroad would be presumably that the locomotive fire should be extinguished,—a condition which could with difficulty be complied with in practical working.

I have spoken a good deal of the permanence of English conditions. In nothing is this more shown than in the railway staff itself. Most companies make it a rule not to take in any servant above thirty years of age. The bulk of the employés come in as lads, being indeed recommended for employment by the fact that their fathers were in the company's service before them. And if they enter the service as boys, they only leave it as a rule either because they have been injured,—in which case they are commonly provided for from some accident fund,—or else because they are too old for work, in which case they are in all probability entitled to a pension or superannuation of some kind or other. Some com-

panies have carried their provision for their employés to such a point that it is practically impossible for any one in their service to come to poverty except by his own fault. All the great companies spend many thousands a year in voluntary contributions of one kind and another for the benefit of their employés. The only class of what is known as the "uniform staff" who are likely to retire at an earlier period than the regulations require are the men who have been fortunate enough to become guards on the crack expresses. What their income may be, I cannot of course tell; but though they are much too well bred to look as if they expected anything, the habit of "tipping" is so universal in this country, and the "tips" are often so substantial in amount, that I am quite sure the figure must be a very comfortable one.

The organization of the governing body of an English company presents some interesting points of difference from your practice. An English railway is managed by a board of directors, nominally elected by the shareholders, but practically, except in very extreme circumstances, coöperative. None of them need be—very often none of them are—practical railway men. The chairman himself is not as a rule a practical man. Most of our great lines are presided over by peers or country gentlemen. Naturally such an arrangement throws great power into the hands of the official who most nearly corresponds to the American railway president,—the general-manager. As his name implies, the general-manager's duty is to be responsible for the general policy of the company. It is his business to negotiate with the neighboring companies, to decide whether new capital commitments must be incurred, and so forth. Of course theoretically these are questions for the board, but a general-manager who is a trained railway man, with a detailed knowledge of the whole of the facts, can hardly fail to impress his own views on a board of laymen. The general-manager is further the undisputed head of the entire traffic staff, and the traffic department with us includes both the getting the business and the management of it when got,—a combination, that is to say, of the two departments recognized in America of traffic and operating. As the head of the operating department, the general-manager's chief assistant is the superintendent of the line, who also discharges the duties of passenger-agent. His chief commercial assistant is the goods-manager. It will be observed that operation proper is only a sub-department with us. Oddly enough, two functionaries who, in America, I believe, would be subordinate to the chief of that

department, the locomotive-superintendent, namely, and the permanent-way engineer, rank with us on a level with the general-manager. The logic of our arrangement is difficult to understand, for it seems clear that the official responsible for working the traffic should have control both over the engines employed for moving it and over the line along which it is moved. It has been said, and I believe with some truth, that the explanation is historical, and that the engineers are, as we term them, "board officers," responsible, that is, to the directors alone, owing to the fact that George and Robert Stephenson, Brunel, and the rest of the great men who founded our railway system, were not traffic officials but engineers.

One point more. Our chairman, owing to his lack of technical knowledge, is usually much less important than the American railroad president. If, however, he possesses this knowledge, he may become almost omnipotent, and this, oddly enough, through the provision of an Act of Parliament which directs that the chairman of the board of directors shall preside at every general meeting of the shareholders of the company. It is obviously most difficult successfully to impeach the conduct of a board, when the chairman of that board, the person mainly responsible for its policy, presides over the meeting and controls its course of procedure. And when from time to time I have read a report of the proceedings at the annual meeting of the Pennsylvania railroad,—I am not aware whether the same course is taken on other lines,—at which a chairman is elected from the body of the meeting, and he invites President Roberts to come up on to the platform and answer any questions his fellow shareholders may ask, I have sometimes thought that, had a similar procedure been adopted in England, more than one of our railways would have been less badly managed than they have been for a good many years past.

The fixity, which, as I have said, before all things characterizes our English railway system, has an important financial result. The established companies can raise unlimited millions by merely holding out their hands for it; they can borrow money at 3 per cent.; they can sell their preference stock at a price only fractionally lower; and they can issue ordinary stock on the basis that the subscriber will be content, if he gets something between $3\frac{1}{2}$ and 4 per cent. per annum for his money. On the other hand, for new lines it is almost impossible to raise money on any terms. A railway in the heart of Africa is much more likely to be taken up by the British public than a new line in the heart of England. The

reasons for this very curious state of things are various. First and foremost, there have been not a few bitter disappointments. New lines that have promised well have come to hopeless disaster; some of them because they were impossible from the outset; others from sheer incompetence of management; others again, because they were "boycotted" by the great companies, so that they might be starved into surrender. Then again, the existing companies sedulously spread abroad the belief, which, though it is doubtless in their interest that it should be held, they, I am persuaded, hold in all good faith themselves, that no new line can possibly be built to pay. The public have had this idea so persistently dinned into their ears for many years past that it has become part of every respectable capitalist's creed. Then again, the regulations laid down by Parliament discourage all speculative construction of railways. The capital of the concern must not be larger than the amount which is sworn to be necessary for the construction and equipment of the line. Of that capital only one-fourth may be in the form of debentures; the rest must be in shares, and for these shares the purchaser is called upon to pay the full face value. The result is to make the prospect of gain from financing a new railway too slight to attract the speculative financiers. On the other hand, the undertaking is too speculative to attract the support of the ordinary investor; while the need of new railways is nowhere sufficiently acute to lead local men to find the money without regard to the possibility of obtaining a dividend on it.

Railway enterprise in England is in consequence almost dead. The great companies spend many millions every year in improving and enlarging the accommodation on their existing lines; but the construction of new lines is practically at an end. There was a time when the different systems were ready to extend into their neighbor's territory; and these extensions produced in their turn retaliation. But that day is past. Each year the *status quo* becomes more firmly established. Each year the railway interest becomes a more closely organized unit for purposes of common action and joint defence. Rate-wars have been unknown in England for a generation past. But competition in facilities and accommodation has lasted down to our own time. Competition is, however, dropping into the background at present. The talk is no longer of new trains, or of the acceleration of old ones. In its stead we hear much of pools, and percentage divisions, and territorial agreements between rival companies. Another ten years of progress in

the present direction and at the present rate will give us a railway system as harmonious and as free from the "waste of competition" as the systems of France and Germany. The school of thought that is in the ascendant in this country at the present moment sees nothing objectionable in the prospect, but rather welcomes a state of things making more easy the transition to that government ownership of all means of communication which it is becoming more and more common to regard as at once inevitable and desirable. It is, however, on competition that our English railway policy has been based from the beginning, and it is by competition that the characteristic excellences of our English railways have been brought out. It is not the men who have the fullest knowledge of our English railway history or the closest acquaintance with the working of the departmental administration of our English government who look forward with the most sanguine confidence to the result of substituting for private competition a monopoly in the hands of a democratic State.

THE COST OF STREET-RAILWAY BUILDING.

By T. William Harris.

IT is the writer's intention herein to give some figures that will be a guide to the investor in estimating the value of any piece of street-railway track, and also to give to those who may wish to build and develop such properties a basis upon which to properly estimate the cost. If any check can be given to the excessive issue of securities,—the ban which has brought so many American enterprises into ill repute; or if any encouragement can be afforded to the timid individual investor to give with his money the life-blood to America's strongest bulwark,—her public works; or if any information can be given to any hopeful promoter by means of which he can demonstrate the value of his enterprise and add one more legitimate paying industry,—which must inevitably in electric-railway building bring other development,—then the writer's object will have been accomplished.

First let us take up a simple case, such as is apt to occur. Suppose that it is required to connect a small city of 12,000 people with a village of half its size, three or four miles distant. Local conditions will roughly determine the route; the franchise requirements generally fix the location in certain streets, while the precise location in the streets, and perhaps the style of rail and general construction, will probably be left to the committee on highways.

Suppose the route be laid down about as follows: Beginning at the Pocono railroad near their depot, up through the City square, where a turn is made at right angles to a street that leads down across a steam-railway track at nearly right-angles, thence out into the country. No curve requiring a guard-rail is met until we come to the outskirts of the village, where we have another right-angle turn, and in the village still another. The first step should be to engage a competent engineer used to such work, and also the best local surveyor. The engineer will wish to ride over the line, then meet the local authorities to get their views, when he will be ready to instruct the surveyor regarding the surveys. The details of the survey, while important, will be passed over as foreign to the subject of this paper. We will suppose that the authorities will allow us to use a T-rail, if we will gravel the

part of the track in the city and village, and plank whatever crossings may be needed outside. For turnouts we will suppose that the running schedule will require three,—one in the city, one in the village, and one about half-way between. There will also be a spur at each end. We shall also require a connection with our car-house; we will put in only one curve, and that from straight single track out in the country. We will use a 45-pound rail, with plain joints and good ties, 2′ 6″ between centers. The engineer makes up from the survey the following data upon which to calculate the cost:

		Feet.
Single-track measurement in the city		8,000
Single-track measurement in the village		4,000
Single-track measurement in the country		12,000
Total length measured as single track		24,000
Of this we find three 200-feet turn-outs, making	1,200	
Two spurs, each 100 feet long	400	
Four right-angle curves, 60 feet center radius	433	
		2,033
Deducting these lengths from the total of 24,000 feet we, have a length, which, while it has some slight changes, we may treat as straight track, of		21,967

It may be asked how I get that length of curves. A curve must have a guard at each end. On this road we have seven such places, and one other end has a pair of switches. The tracklayer will fix that end all right with an odd bit of rail. I have not deducted the slight pieces of straight track taken out by the tongue-switch and mate, and the steam-railroad crossing, as we must allow something for waste. The turnouts will cost each complete about $375, curves suitable for this track about $1.50 per foot, the steam-railroad crossing $165, and the tongue-switch, mate, and frog $80. For straight-track material rails will cost 45 cents per foot, joints 3 cents, and pipes 2 cents. Ties we will figure at 45 cents each, or 18 cents per foot of track.

Now we have 12,000 feet from which we must, according to our franchise, excavate six inches of the old material and fill in nice new gravel. This being in the streets, old bricks, plaster, broken stone, cinders, and tin cans will be encountered. To dig out and load it into wagons will cost probably not less than 25 cents a cubic yard. This must be carted out along the line to make some little fills. A team will stand still during loading and unloading about half the time, and we will suppose that it will travel $3\frac{1}{2}$ miles an hour the balance of the time, or 16 miles a day, making the cart-

ing cost us 20 cents a cubic yard. The new gravel delivered alongside the track we contract for at 75 cents a cubic yard. This gives a total of $1.20 per cubic yard, which, spread six inches deep over a surface six feet in length and nine feet wide, makes 20 cents per foot of track. Out on the line the engineer finds that in addition to the earth already supplied there will be work that will require on the whole of the country part of the line the equivalent of a bank nine feet wide by one foot high, or one-third of a cubic yard. This will be picking down banks, regulating gutters, ballasting, and other such work, at a cost, say, of 21 cents a yard, or 7 cents per foot of track.

The track-laying, if well done on this style of work, will cost about 15 cents per foot, and on curves and turnouts 50 per cent. extra. Next we come to bonding the rails to make the return circuit to the station. Material and labor on this cost about 4 cents per foot of track. As to planking some street-crossings and driveways, the engineer says there will be 800 feet of track to be attended to. Eight hundred feet long, 7 feet wide, and 3 inches thick will give us 16,800 feet, board measure—or 17,000 to allow for waste—of 3-inch plank, which in place will cost $25 per thousand, or $425. Let us sum up what the track will cost :

Straight track per foot, for rails, spikes, and joints	$0.57
Track laying	.15
Bonding	.04
Ties	.18
Total on straight track	$0.87

This is the price that we will often find figured up for the whole line,—first, by those who know no better ; second, by the promoter who is unscrupulous, and wants to make his road look cheap ; and third, by the investor who has got a few prices in his head from a rail-man and wants to demonstrate that a really good property is bonded too high and must inevitably go to smash, for which reason he, overcautious, refuses to buy the securities and loses a chance for a good investment. But let us count up the extras :

Three 200-foot turnouts @ $375 each	$1,125.00
433 feet curves @ $1.50 per foot	649.50
Two 100-foot spurs	375.00
2033 feet track-laying on curves and switches @ 22½ c.	457.42
2033 feet of bonding @ 4 c.	81.32
One steam-railroad crossing	165.00
Ties for 2033 feet of track @ 18 c.	365.94
12,000 feet track graded @ 20 c.	2,400.00
12,000 feet track graded @ 7 c.	840.00
Planking	425.00

Tongue, switch-mate, and frog for car-house connection	80.00
4½ miles surveying at say $75 per mile	337.50
	$ 7,301.68
To this we must add 21,967 feet straight track @ 87 c.	19,111.29
Making the net cost equal to	$26,412.97
To this add contractor's profit, 10 per cent.	2,641.30
	$29,054.27
To this add engineer's fees, 5 per cent.	1,452.71
Total cost of 24,000 feet of track, complete	$30,506.98

[Or about $1.27 a foot.]

Exceptions will perhaps be taken to the charge of graveling, as being unusual, but I have put this in (1) to caution inexperienced people who are asking cities for franchises, that they may be careful to have all such matters left out, and not go to Wall street with a franchise so bound up with requirements as not to be of value; and (2) to show the banker and investor where a little change in a franchise can sometimes save a good deal in first cost.

Let us now take up a more expensive case,—that of a small city that has some stone paving and hopes to have more. They say that we must use a girder rail on the whole line, and on all but two streets put on chairs or otherwise elevate it so as to leave room on top of a tie to bed a paving-stone. We will adopt rails weighing about 50 pounds per yard, which are usually sold by the foot, and the price includes joints and spikes. We will place our ties 2′ 6″ on centers and use chairs; tie-rods we will put in on the track requiring chairs, once in ten feet. Our engineer reports as follows:

	Feet.
Straight track on chairs	18,000
Straight track direct on the ties	3,000
Curved track requiring guard-rails	1,000
Two railroad crossings	
Four 200-foot turnouts, equal to	1 600
Three sets of tongue-switches and frogs for branch-offs	
Total length of line, measured as single track	23,600

Of this he finds 3000 feet already paved with stone. It matters little whether this is cobble, limestone, hard sandstone, trap, or granite, for our present purpose, as we have simply to relay it and furnish some little new sand. The cobblestone may cost a little less to relay, but will require more sand. Usually the authorities will allow us to use the old sand to bed the stone in, if we furnish nice new sand to cover off our paving. For this purpose will be required at least two inches in depth over all the pavement relaid,

which will usually be nine feet in width or one square yard per foot of track. Some man will say that we do not have to pave 400 square yards in paving a 200-foot turnout. Let him fuss with a turnout once, doing probably one side at a time, with the bother of paving round the frogs and switches, and he will not want any cut made in the item of labor for his paving. Let us look at the prices and see what this piece of work will cost:

Straight track on chairs, 18,000 feet @ 65c.	$11,700.00
Straight track on ties direct, 3000 feet @ 65c.	1,950.00
Curved track, 1000 feet @ $2 40.	2,400.00
Four 200-foot turnouts, (1600 feet) @ $650	2,600.00
Three sets switches and frogs @ $175.	525.00
Two steam-railroad crossings @ $170	340.00
Chairs for 18,000 feet straight, 1000 curves, and 1600 feet turnout @ 32c.	6,592.00
Tie-rods for 20,600 feet @ 3c.	618.00
Track-laying, 18,000 feet straight @ 25c.	4,500.00
Track-laying, 2600 feet curves and turnouts @ 37½c.	975.00
Track-laying on ties direct, 3000 feet @ 20c.	600.00
Repaving, 3000 feet @ 23c.	690.00
New sand for repairing, 2" deep or 166 cu. yd. @ $1.25	207.50
Bonding, 23,600 feet @ 4c.	944.00
Ties, 9440 @ 45c. each or 18c. per foot of track.	4,248.00
Surveying about 4½ miles @ $75 per mile.	337.50
Total net cost.	$39,227.00
Add contractors' profit, 10 per cent	3,922.70
	$43,149.70
Add engineer's fees, 5 per cent.	2,157.50
Total cost of 23,600 feet of track	$45,307.20

[Or very nearly $2 per foot of track.]

We have a track good enough for a city of say not over 40,000 people, especially if the road is a new one, the earning capacity of which remains to be demonstrated. It has been assumed that this track has been built in gravel streets, but if there should be a macadam surface on these streets, making excavation difficult, or if they should be of clay so that the road-bed would have to be graveled, the cost would be greater, of course; but usually $1000 per mile will cover a good deal of such work.

Let us now look at still another style of construction for this track. Suppose that instead of chairs we should put a longitudinal stringer $4''\times4\frac{1}{2}''$, laid on the $4\frac{1}{2}''$ face. This might be of Southern yellow pine, vulcanized or creosoted, supported on rather better ties than we had before, costing, say 50 cents each. But on account of the additional strength of the stringer, the ties would not need to be nearer than one in every four feet. The ties and stringers can be connected with rolled steel knees, and the rails spiked to

the stringers with reverse-pointed spikes. The labor on this work will be a little more than before. There is a good chance to tamp the whole length of the stringer, and the stringer will also afford a lateral support to the paving stone. On curves the timber is sawn in strips 1½″ to 2″ thick; three of these are put together, bent to the proper radius, and thoroughly spiked and bolted together, when they will hold their shape pretty well after being taken from the mold. The writer has done this successfully with cypress lumber at Savannah, Ga. We will only take up the cost of one foot of straight track and compare it with the chair construction, as follows:

	Chair construction.	Stringer construction.
Rails, spikes, and joints	$0.65	$0.65
Rods	.03	.03
Chairs	.32	...
Ties	.18	.125
Bonding	.04	.04
Labor	.25	.30
Stringers, 4″x4½″, pine, treated at $30 per M	...	.09
Knees and knee-spikes	...	.10
Total per foot	$1.47	$1.335

In my opinion the stringer style of track is far ahead of the chair construction. I am well aware that this will be criticised very strongly by the makers of chairs, but let any one put two rough surfaces of iron together and subject them to any jar, no matter how slight, and see the result at the end of a few months. The chair-men may say that I have put too high a price upon my chairs, but they will hardly agree to furnish really good ones for less. They may say that I use them unfairly in putting the ties with chairs 2½ feet apart and the others 4 feet, but let us see how the bearing surface that we can tamp up solidly compares in each case. Consider one foot of track, chair construction: ties 7′ long, 7″ face, 2′ 6″ between centers=235 square inches per foot of track. In the stringer construction, stringers 4½″ wide, ties as before, only 4′ between centers=255 square inches per foot of track. Besides, we have figured the tie in this construction as being worth 5 cents more than the others, so we may have an 8″ face on that. The chair-men may say that they tamp under the foot of the rail; if you stand over the work constantly, you may get some little work done on this, but it is a very hard place to get much good out of the labor, as it comes above the bottom of the paving-stones. The pavers may be instructed to fill and ram that space with their hammers, but they cannot do it well enough to be of value. Now that

the vulcanizing process gives us clean and durable timber, free from many of the objections of the older processes, there can be no excuse for not using some sort of a preserving process on stringers.

The writer once had a contract to rebuild a piece of track subject to a very heavy traffic ; a splendid girder rail was used, weighing at least seventy pounds a yard, and the ties were good oak and chestnut, but what was put between them? It was an untreated spruce stringer. I remarked to the engineer that he had a bad piece of meat between two good slices of bread in his sandwich, but the great and glorious public eagerly buy up securities founded on such a construction, never stopping to ask where the end will be, or taking independent professional advice as to the durability of the construction which their money goes to pay for.

Here I would urge upon those who are to build and those who are buying securities to look well to the *ties*. Suppose we have a 4″x6″x7′ tie, four feet between centers,—and this is not an uncommon case,—what bearing per foot do we get? Only 126 square inches, a poor sort of bearing for a foot of an electric railway. Then, too, that tie is buried out of sight and cannot be tamped up now and then like a tie on a steam-road. A friend who has been a civil engineer on a steam-road now figures out that an engine weighs a great deal more than an ordinary electric car. He then goes at car-mileage, and stops, wondering where his mistake is. Somehow the electric cars give the track a great deal of work, and he cannot be right in his figures, but my friend has made no mistake. There are cases where we have to pass a great many electric cars over a piece of track in twenty-four hours, and there are the teams, often heavily loaded, which bang down on a piece of track from a high paving stone, giving a very intense blow.

But I began to talk about ties. We started in with a 4″x6″x7′ tie and found that it gave very little bearing surface per foot of track. How is it best to change this? We do not want to make our tie much longer, as we must keep our excavation, in crowded streets, as narrow as possible. As for thickness, if the rail is not very high, or is held by rods or braces so that it has but little tendency to turn over, it will not pull hard on the spikes. The case is different from a steam railroad, where the heavy drivers of an engine will spring almost any rail and cause a spike to draw. But in electric work we have an immense number of light, rapid blows ; our track acts more as a unit and we do not need so much strength in our spike, but we do need bearing surface, and the spike must

not prick through the tie and allow the point to split out a sliver on the bottom of the tie. Usually a tie 4″ thick will do for light rails, 4½″ for medium weight, and 5″ and over for very heavy and high rails that require spikes of great holding power. Thus we can give our track a good amount of bearing per foot without making it very expensive. Suppose again that we have a good rail in hand and make the tie 4″x9″ instead of 4″x6″. We can tamp the 9″-tie with a very little more labor than the 6″-tie, and it takes the same number of spikes; but, when it comes to the matter of tie-holes and spiking, we find a saving over increasing the number of ties; besides, a broad tie does not cut into the ground as a narrow one does. Any old section-boss who has tried to keep a piece of track in place during heavy rains, where he had only a clay bank to work on, will tell you to put in big ties,—great wide ones.

Lately I saw a rail that must have weighed over 100 pounds to the yard, laid for an electric railway, but they were putting under it little bits of ties,—mere whipsticks. I suppose that the managers thought their duty to the stockholders was done when they bought that rail, and they never stopped to think of its support, buried out of sight, although this was the most vital point of all. Or perhaps they felt sure that the rails would sell their stuff for them and trusted to the penuriousness of the purchasers to keep them from expert examination. An ordinary steam railroad will have about 380 square inches of tie-bearing surface per foot of track, and we must come as near it as we can with our electric roads, either with ties alone, or by using stringers under the rails.

We may now take up a case of still more substantial and intricate construction. It is desired to build a double track through a city street, from which a double track leads off, giving us two cross-overs, besides a lot of single track and turn-outs in the outskirts of the city. The requirements are for what we will designate as Class A, with 10″ above the top of tie to top of rail, as the paving stones are to be 7″ to 8″ deep; and for what we will designate as Class B with 6″ above the top of tie to top of rail. The survey is made and turned over to the engineer, who makes up the following schedule upon which to base estimates:

	Feet.
Class A.—Straight track	20,000
Cross-overs	200
Curves requiring guard-rails	800

Of this track 15,000 feet are now paved, and we must repave it, and 5800 feet we are required to pave new.

	Feet.
CLASS B.—Straight track in Macadam	15,000
Straight track in gravel	5,000
Curves requiring guard rails (in Macadam)	500
Six turnouts, 200′ each (in Macadam)	2,400
Pairs of tongue switches	5
Pieces of special work	13

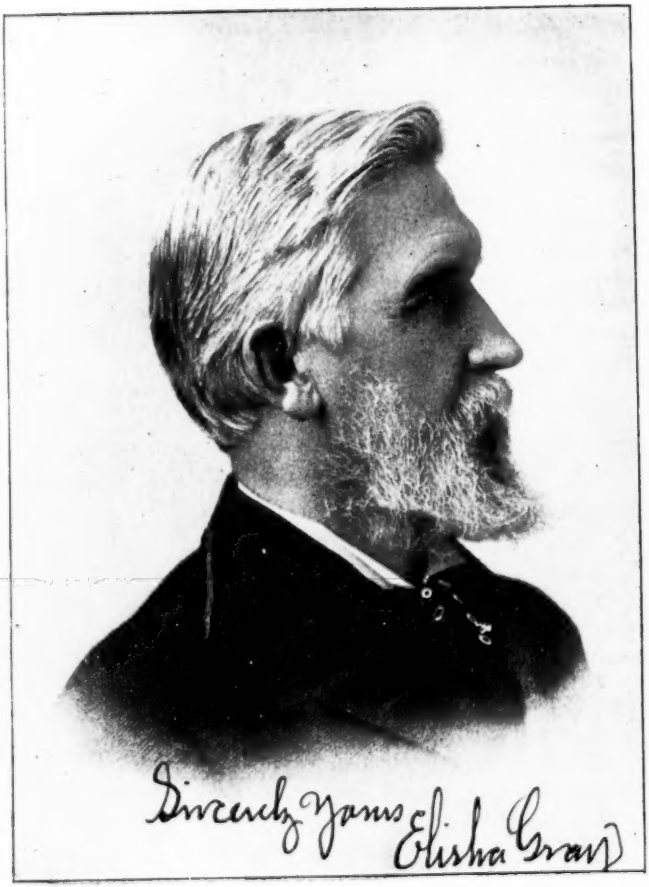
It is evident to one accustomed to such work that, having taken hold of a job in a large city, we must provide for solid business. Let us use a 70-pound girder rail, 6″ high. In Class A we will have a 4½ x4″ Southern yellow-pine stringer, and on the whole of the line we will use a 5″x9″x7′ Southern yellow pine tie, treated as before. Here another problem is met. We have all along merely bonded our track, but here we have many cars, and we must attempt to fix up a better return. We will put in a good ground wire and tie it to each end of each rail and special piece. We may also bond the rails as before, and put in good grounds along the line. This is all that we can do unless we run an independent overhead return, which is rarely needed. In this estimate we will figure our return as costing 12 cents per foot of track, which will usually cover the cost in such cases. Such ties are expensive, I know, but we want a good foundation to build on and we do not want a heavy repair-bill for a long time to come. The estimates will be :

CLASS.	Cost.
A.—Straight track, 20,000 feet, @ 90c	$18,000.00
Two cross-overs, (200 feet) @ $600.	1,200.00
Curves, 800 feet, @ $2.60	2,080.00
B.—Straight track, 20,000 feet, @ 90c	18,000.00
Curves, 800 feet, @ $2.60.	2,080.00
Six 200-foot turnouts, (1200 feet) @ $800	4,800.00
Five pairs tongue-switches @ $175	875.00
Thirteen pieces special work @ $60	780.00
Ground-wire, or return, 44,200 feet, @ 12c	5,304.00
A.—Track-laying, 20,000 feet, @ 35c.	7,000.00
Track-laying on curves, etc., 1000 feet, at 52½c	525.00
Extra excavation and disposal of waste on new paved work, 5800 feet, @ 10c	580.00
Repaving, 15,000 square yards @ 25c	3,750.00
New paving (a hard matter to estimate off-hand) 5800 feet, @ $3.50	20,300.00
Ties, 4′ c. c. @ 80c	4,200.00
Stringers, 4″x4½″, at $30 per M	1,890.00
Knees and knee-spikes, @ 10c per foot.	2,100.00
Sand for repaving 1500 square yards, 2″ deep	1,041.00
B.—Track-laying, 15,000 feet in Macadam, @ 35c	5,250.00
Track-laying, 5000 feet in gravel, @ 30c	1,500.00
Track-laying, 3200 feet curves and turnouts, @ 52½c	1,680.00
Ties on 23,200 feet, 2′ 6″ c. c. @ 80c	7,424.00
Rods on whole line, 44,200 feet, @ 3c	1,326.00
Surveying (part of the line is double track, and thus cheaper)	600.00
	$112,285.00

Amount forward	$112,285.00
Contractor's profit, 10 per cent	11,228.50
	$123,513.50
Engineer's fees, 5 per cent	5,675.50
Total	$129,189.00

This is a little less than $3 per foot, and we have a first-class track for ordinary heavy traffic. Of course the semi-grooved rail, or electrically-welded chairs or joints, would cost more, but it has been the writer's aim to give such examples as come up often, and such estimates as are likely to be of real value to a large number of readers. Some may have followed me to this point, saying from time to time that estimates were not given on work good enough for them, but that at last, when one was given to suit them, they found the price too high. I do not want to discourage them; they may be wrong in their requirements. If the matter has any good points at all, consult the nearest engineer skilled in this kind of work and he may show you a way out of your trouble. It is not the actual *cost* usually that founders any enterprise, but the *water*.

It having been the writer's privilege for eight or ten years past to be much on the moneyed streets of the Eastern cities, a word to out-of town promoters who want to sell bonds may not be amiss. To such I would say: start with the idea that, while it is not an impossible thing to do, it is hard work to sell unknown securities in the large cities. If possible, first build the road. Then make a good trust company—in New York, for example—trustee of the mortgage, taking care that the mortgage is drawn by a competent attorney. Then take to the money center the best introductions obtainable, and you will find that people have time to listen to you. But if you go with nothing but a scheme in your mind, you will find it up-hill work all along. If material is advanced, it will be on very long prices, and finally some construction company will gather you in, and it will be found when the road is built that you have paid a tremendous price for the property, and then to pay the interest and the repair account on the slop work will keep you poor forever. A road skilfully designed for the traffic at hand, and built for cash, is usually good property. But a poorly-designed, poorly-built road, with a liberal dose of "water" in the securities, is a disastrous undertaking for the first owners and an injury to every good, well-balanced enterprise in the country.


Sincerely yours
Elisha Gray

PROFESSOR GRAY'S NEW TELAUTOGRAPH.

By William Maver, Jr.

IN the operation of telegraph systems generally, whatever the form of device used or the method of transmission, the message reaches the receiving-station in the form of dots and dashes, which have to be translated into words by operators trained to the work. There have been many attempts, however, to utilize the idea of an apparatus for writing at a distance in fac simile. There is now on public exhibition in various cities of the United States an apparatus for this purpose, invented by Professor Elisha Gray and termed by him the "telautograph," the result of which has been such success as to justly direct renewed attention to the subject of what may be called writing-telegraphy. In order that the merits of this late invention may be properly estimated, it will be well to consider the work of some of the earlier experimenters in this line.

Fifty years ago Alexander Bain, of Edinburgh, devised an apparatus whereby written or printed characters formed in metal and set up at a sending-station were reproduced in fac-simile at a receiving-station through the agency of electricity. An idea of the manner in which this was accomplished may be gathered from Figure 3. The letters at the left, composing the word B A I N, were inserted in the path of an electric current for which five wires were employed. The ends of the wires were caused to pass over the metal letters at a given rate of speed and at the same time the ends of the wires at the receiving-station were caused to pass over chemically-prepared paper at a corresponding rate. While the wires at the receiving-station were passing over the metallic letters, the electric current flowed in the wires, and at such times the electric decomposition of the solution contained in the paper ribbon at the receiving-station proceeded, forming brown or blue marks on the paper, according to the nature of the material used. Contrariwise, when the wires left the metallic letters, the current ceased to flow, and decomposition of the solution stopped. The cause of the broken appearance of the received letters in Figure 3 is thus accounted for. Had the wires been more numerous, or the metallic letters smaller, the breaks in the received letters would have been

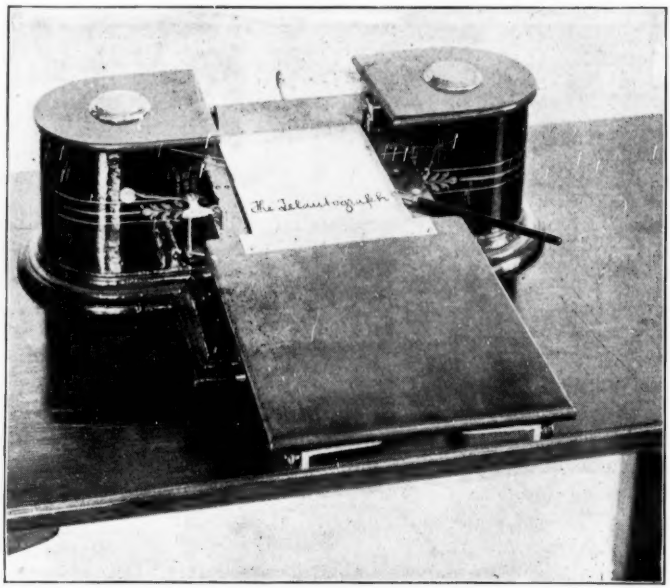


FIG. 1—THE TELAUTOGRAPH TRANSMITTER.

less pronounced. This statement is illustrated by reference to Figure 9, in which the characters are made up of lines much closer together. In some later forms of telegraphy in which the foregoing principle has been employed the characters to be transmitted have been written on tin-foil in insulating ink, and a terminal of the line wire has been caused to pass over the surface thus prepared, with a result practically similar to that attained by Bain. It is evident that one is not limited to written characters in telegraph systems of this kind, since even small pictures may quite as readily be reproduced.

One of the best known of the writing- or copying-telegraph systems is that invented in 1856 by Abbé Caselli, of Florence. The apparatus employed at each station in this system is shown by Figure 4. It consisted of a pendulum six feet in length, with an iron bob weighing sixteen pounds, suspended from an iron frame. The pendulum was caused to oscillate between electro-magnets, shown opposite the bob, by the alternate opening and

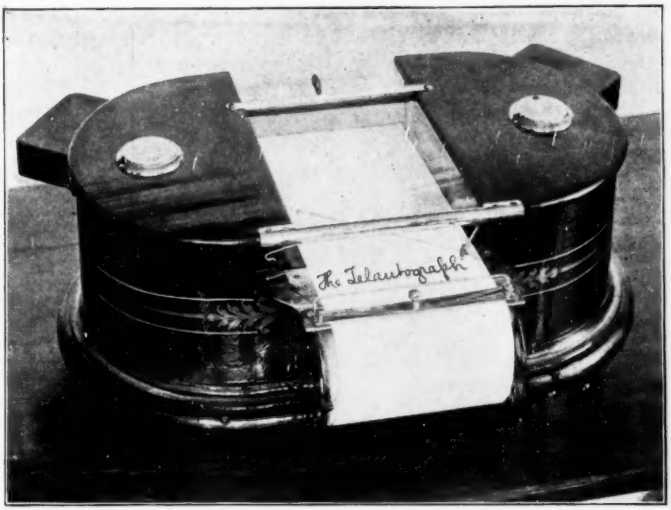


FIG. 2—THE TELAUTOGRAPH RECEIVER.

closing of a local battery, controlled by a "circuit-breaker," represented at the upper left corner of the figure. At each side of the frame was placed a curved iron tablet, over which a pen attached to the main-line circuit was caused to pass. One of these tablets served as a transmitter, the other as a receiver. The pens received their motion from the pendulum by means of rods and levers, only one of the pens, however, being connected to the pendulum at once. The tablets were also, by suitable mechanism, given a slow motion at right angles to the crosswise movement of the pens. A message to be transmitted was written in ordinary ink on silvered paper which was placed upon the surface of the transmitting tablet. A sheet of chemically-prepared paper of similar size was placed upon the receiving-tablet at the distant station. The movement of the pendulum at each station then produced a correspond-

The Sender. The Receiver.

FIG. 3—THE BAIN CHEMICAL TELEGRAPH.

ing movement of the transmitting- and receiving-pens over their respective tablets, and as a result current flowed or stopped in the circuit according as the transmitting pen passed over the inked or clear surface of the silvered paper. The right-angle motion of the tablets was so arranged that the consecutive passages of the pens across the paper were separated by a very small space, as will be seen by examining the lines forming the characters in the specimen of the work done by this system, shown in Figure 9. A receiving-tablet showing a partly-completed head is illustrated in Figure 5. This system was operated practically between Paris and Marseilles, a distance of 560 miles.

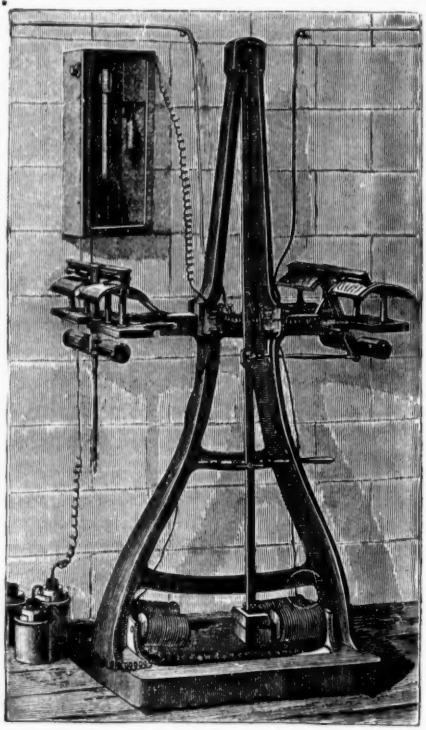


FIG. 4—CASELLI'S COPYING-TELEGRAPH.

Modifications of this system have from time to time been introduced,—for example, the Denison auto-telegraph,—but apart from Caselli's no copying-telegraph has been practically employed to any notable extent. The Denison auto-telegraph was virtually a miniature Caselli copying-telegraph, the pendulum and tablets of the latter being replaced by small arms which were caused to traverse, at a high rate of speed, paper ribbons at the receiver and transmitter. The arms were operated by a "circuit-breaker."

Autographic electric systems — or telautographic systems, strictly speaking—may be distinguished from fac-simile or copying telegraph systems by the fact that in the former the characters

are electrically transmitted and reproduced at the receiving-station at the very time they are being formed by the pen or pencil in the hands of the operator at the sending-station. It is plain that any device whereby this result can be accomplished, easily, quickly, and without intricate apparatus, will be of much utility in a variety of places. For instance, by its means a merchant could send instructions from his office to his factory; brokers could give quotations and execute orders without dispute,—the correspondence being virtually, as the name of the system implies, in the handwriting of the contracting parties; sketches requiring despatch could

FIG 5—CASELLI'S RECEIVING TABLET.

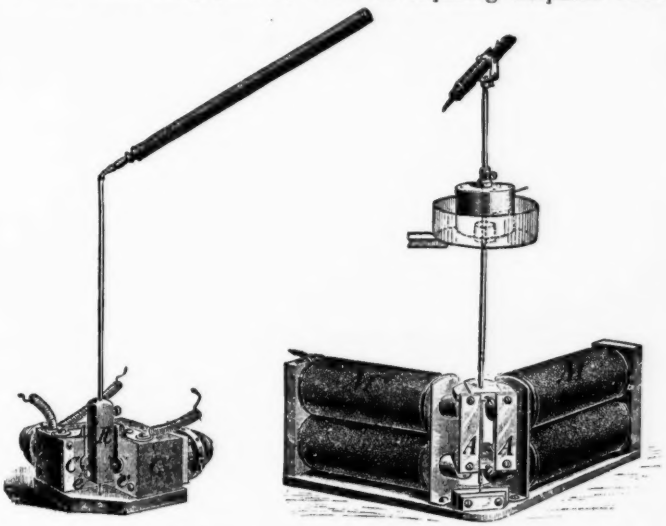


FIG. 6—ROBERTSON TRANSMITTER AND RECEIVER.

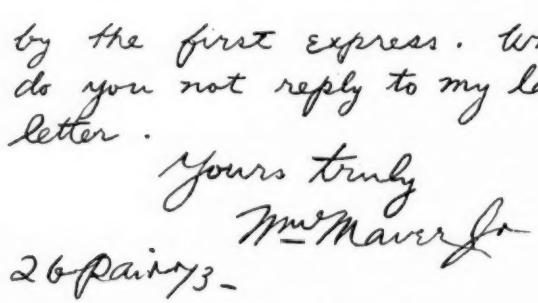


FIG. 7—TELAUTOGRAPH MESSAGE AS WRITTEN.

be transmitted in the act of preparing them. If it be said, as regards the Morse telegraph and telephone, that orders and quotations can as quickly be sent, the reply may be made that, in the case of the telegraph, expert operators are necessary; while in the case of the telephone the difficulty in the reception of certain articulate sounds, as well as the absence of a record, diminishes its usefulness in many transactions.

The first inventor in the line of telautography, I believe, was Mr. E. A. Cowper, of England, who termed his invention, made in 1874, a writing telegraph. In this case the transmitting-pen was held as in ordinary writing, the desired characters being placed on a strip of paper, which was caused to move slowly to the left as the letters were formed. At the same time a pen at the receiving station was caused to form characters corresponding to those made by the writer of the message. This pen was supported by a rod attached to an armature between two small electro-magnets, and

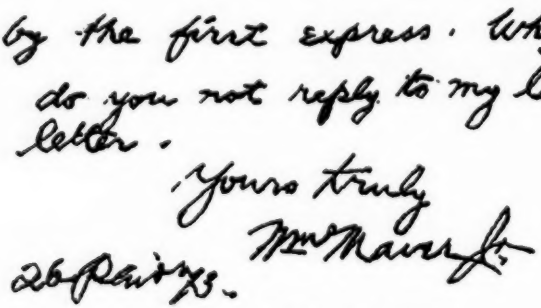


FIG. 8—THE ABOVE MESSAGE AS RECEIVED.

its movements depended upon variations of the magnetic strength of those magnets. These variations of magnetic strength so acted upon the armature as to give the receiving-pen all the motions of the transmitting-pen. Each of the electro-magnets referred to was placed in a separate circuit, and the variations in their magnetic strength were brought about by variations in the strength of current flowing in the circuits, which latter variations were produced by changes in the electrical resistances of the circuits; it

FIG. 9—WORK DONE BY CASELLI'S TELEGRAPH.

being well known that the strength of current in a circuit varies proportionately with the resistance.

The theory on which Cowper's system was operated is really that of compounding the movements of a point in two directions, the one at an angle to the other, the movement of the point being the resultant of the two movements.

The following illustration may help to make the operation of

the receiving-pen clear. Suppose a buoy to be anchored by an elastic rope, in a river opposite the mouth of a tributary whose waters enter the main stream at right angles to the direction of the former. If the force exerted by the water flowing in both streams be equal, it is plain that the buoy will be moved, against the pull of the elastic rope, diagonally between the directions of the two streams, and if this force be diminished the elastic rope will retract the buoy to its normal anchorage; but if the force of one stream be greater or less than the other, the buoy will be deflected to a position corresponding to the resultant force of the two. Hence, if means should be devised whereby the outflow of each stream could be simultaneously regulated by the turning on or off of valves, or gates, by means of suitable levers, it is obvious that the buoy might be caused to take any desired position, or to move in any desired curve, within given limits, by one having control of the lever.

FIG. 10—MESSAGE ON THE ROBERTSON TELEGRAPH.

The Cowper writing-telegraph was never practically used, and little was done in the line of telautography until about 1884, when Mr. J. Hart Robertson, of New York, working upon the general principles laid down by Mr. Cowper, succeeded in producing various important improvements in the transmitting and receiving instruments. Further improvements in the transmitter were introduced by Mr. H. Etheridge, of Pittsburgh, Pa., and writing-telegraph circuits, embodying these improvements, were placed in practical operation in Pittsburgh and in Rochester, N. Y.,—in the latter city for reporting baseball news, and on private lines.

On these circuits the sender used a pen whose movements were limited to a space not exceeding an inch square,* and the movement of the receiving-pen was con-

* The transmitter consisted of two rows of small disks of carbon, placed at right angles to each other. The disks were placed within suitable cases, side by side. Each row of disks was included in an electric circuit, and one of the electro-magnets, similar to those used in Cowper's telegraph, was placed in each circuit at the receiving end. The transmitting-pen was provided with projections on its sides opposite the carbon disks. As the pen was moved in the act of writing, these projections pressed, more or less strongly, against the carbon disks, and as the electrical resistance of carbon decreases quite materially under pressure, the consequence was that the strength of current in the respective circuits was varied according to the movement of the pencil, with the result already outlined. The writing-pen employed was carried on the flexible elastic rod, as shown. The drum-

fined to a corresponding area. The transmitter and receiver employed in this system are shown at the right and left, respectively, of Figure 6. In writing by this method it was necessary to form the characters, one on top of the other, so to speak, since, as I have stated, the movement of the pen was confined to so limited an area, the platen on which the pencil rested being stationary; and no little skill was required in the use of the sending-pencil to produce intelligible writing at the receiving end. This skill could be acquired by practice, though I must confess that, after having had several opportunities, I did not become expert enough to do any work at all comparable with the specimen of writing done by the Robertson-Etheridge telegraph shown in fac-simile in Figure 10.

It is not much to be wondered at that this system was not more generally adopted. Its extension was doubtless hampered and its sphere limited by the amount of skill necessary to use it, and by its inability to reproduce any but written characters. The plan upon which the movements of the receiving pen was based—namely, the increase and decrease of current strength on the circuits, or variable resistance method—also militated against its success, especially on long circuits.

In the telautographic system just completed by Professor Elisha Gray,—to whom, I believe, the term "telautograph" is due,—many imperfections and defects of previous writing-telegraphs, including his own earlier inventions, have been avoided. For instance, the improvement in the matter of writing has been carried to such an extent that one who sees the apparatus for the first time, as in my own case, may take the sending-pencil, and, without moving the paper before him, write or sketch, upon a space five inches wide by three or four inches long, characters which will be at once reproduced in ink in exact fac-simile at the receiving instrument. Figure 7 is a specimen of writing done carefully on this instrument at my first attempt. Figure 8 represents the same writing as it appeared on the receiver. In other words, Professor Gray has succeeded in producing what would be termed a "page-and-line" writing-telegraph system, in contradistinction to a single-line or strip writing-system, and by means of which any one who can handle a pen or pencil may have the work of his hand electrically

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shaped vessel shown midway up the rod carried a small quantity of glycerin, in which a "damper" attached to the rod was placed to steady the movements of the pen and to prevent it from wavering.

reproduced at a distance, by a method not materially affected by ordinary changes in the insulation of the circuit.

To accomplish these results, Professor Gray has abandoned the variable-resistance method of obtaining the desired movements of the receiving-pen, adopting instead what is termed a "step-by-step" method, which will be referred to on another page. The principle of "compounding the point," previously referred to, is retained, however, but, as compared with the writing-telegraph system of Cowper, has been greatly amplified, as must be obvious in view of what has been said as to the range of the writing- and receiving-pens.

If it were within the scope of this paper to give a detailed technical description of Gray's improved telautograph, I would be debarred from doing so by the fact that certain of its important features have not yet passed through the patent-office, and that the mechanism of the apparatus in its entirety is therefore not accessible for inspection. But it will be possible with the aid of illustrations to give a fair idea of the manner of its operation. The transmitter and receiver are represented by Figures 1 and 2, the essential instruments and mechanism being enclosed in the iron boxes shown. The paper on which messages are written and received is in a continuous roll, as indicated, about five inches wide.

In writing, an ordinary lead pencil may be used. Near the point of this pencil two silk cords are fastened, as indicated in the figure. They diverge from the pencil at right angles to each other, and enter the iron case through suitable apertures. Each cord is wound upon a small drum mounted upon a vertical shaft, each shaft carrying also a small toothed wheel. Each wheel, in moving, operates an escapement which, in turn, causes an electrical contact point to oscillate in such a manner as to send pulsations of positive and negative polarity over the two main line wires employed for the transmission of the writing. The number of pulsations thus sent over the wires depends upon the rate at which the toothed wheels are caused to rotate by the movements of the silk cords around the drums. If the pencil is moved one inch in the direction of either of the cords, 40 teeth of the wheel attached to that cord will be caused to pass a given point, and 40 pulsations of each polarity will flow over the line wire. It will depend upon the direction in which the pencil moves whether both the toothed wheels will be rotated at once,—causing pulsations to pass over both of the transmitting wires at once,—or whether a greater or less number will pass over

either wire. Likewise the movement of the receiving-pen will depend upon the rapidity of these pulsations and upon the number that pass over the respective main line wires, for the telautograph receiver is an instrument operating in a reverse manner to that of the transmitter, as the receiver of the telephone acts reversely to the transmitter. In the latter case air-waves started by the voice cause the diaphragm of the transmitter to set up electrical waves

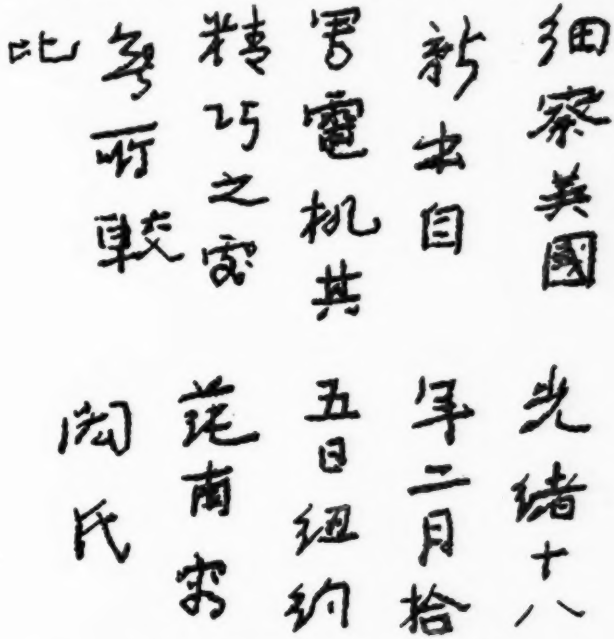

FIG. 11—CHINESE MESSAGE BY THE TELAUTOGRAPH.*

of corresponding quantity in the wire ; these electrical waves in turn cause vibrations in the diaphragm of the telephone-receiver similar in quantity to those of the transmitter, and the latter institute air vibrations, which are reproduced in the ear as sound. In an analogous manner, depending upon the movement of the sending-pencil, the telautograph transmitter sets up in the wires pulsations of

*A close examination of the newly invented self-writing electric machine reveals the fact that in point of ingenuity and convenience it is beyond compare.

YUNG WING.

New York, 31st March, 1893.

a given frequency, which pass over the wires and set up pulsations in the receiving instruments, which pulsations in turn are caused to move the receiving-pen in a manner precisely similar to that of the transmitting-pencil. But whereas in a telephone receiver the amplitude of movement of the diaphragm is much less than that of the transmitter in the telautograph receiver, the amplitude of movement of the pen is exactly equal to that of the transmitting-pencil. Its movement could be made greater or less than the transmitting-pencil, however, by adjustment of the parts, in a manner analogous to that by which this result is accomplished in the pantograph. Indeed, as Professor Gray has suggested, his invention could properly be termed an electric pantograph.

To bring about the result mentioned at the receiving station, two "polarized" relays and certain other apparatus are employed. One relay is placed in each of the main wires. Each relay controls an escapement which in turn engages with a toothed wheel on a vertical shaft carrying a small drum, this mechanism corresponding to that in the transmitter, already described. To each drum is attached an aluminum pen-arm by means of cords, on the principle of the well-known bow-drill. The pen-arms are hinged together at the writing point, as may be seen in the figure. A small rubber tube, one end of which rests in an ink-well, passes through one of the pen-arms to the writing-pen, which is a small glass tube placed at the junction of the aluminum arms. As the pen passes over the paper the ink is deposited, the supply being maintained by capillary action. The toothed wheels in the receiver are given a tendency to rotate by any suitable motive power (at present a small electro-motor is employed), but they are held in check by the escapements. Hence, as the movements of the escapements are governed by the polarized relays, which in turn are controlled by the toothed wheels of the transmitter, every movement or "step" of those wheels will be duplicated by the toothed wheels in the receiver. Consequently, the movements of the transmitting-pencil in any direction will be followed by the receiving-pen. If, to borrow the language of Professor Gray, the sending-pencil be started from the center of the writing tablet and be caused to describe a line to the right at an angle of 45 degrees from the horizontal, only the right-hand escapement of the receiving instrument will be operated. Contrariwise, if the pencil should be moved from the center, drawing a line to the left, at a similar angle, only the left-hand escapement at the receiver will be operated. If the pencil be moved vertically,

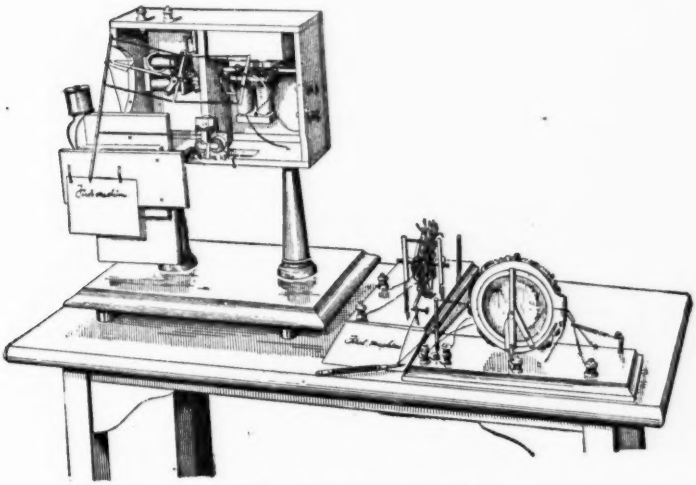

FIG. 12—GRAY'S FIRST MACHINE.*

both escapements at the receiver will be moved vertically, and *vice versa*. If the sender should describe a circle with his pencil, the receiving drums would both be acted upon exactly as are the sending drums, and the resultant of the two right-angle motions properly proportioned to each other would be a circle; on the principle of the "compounding of a point," to which reference has been made.

It would seem that the force which drives the shafts on which the drums controlling the receiving-pen are mounted would tend always to move the pen in one direction,—either up or down the paper,—in accordance with the movements of the escapements. That such is not the case is due to the employment of an ingenious mechanism in the receiver, controlled by the transmitter, which reverses the direction of the driving-force of the receiver simultaneously with every change of the transmitting-pencil, as from an up to a down stroke.

As shown in Figure 10, the writing received on the Robertson-

*This cut shows the first machine, completed early in 1887, from which writing was obtained. It was constructed on the variable resistance plan, but no provision was made for raising or lowering the pen or shifting the paper, these functions having to be performed by the receiving operator. On account of the numerous objections to any variable resistance system this principle was abandoned and the step-by-step principle adopted. Patents were, however, applied for on this machine in the fall of 1886, and notice has just been received from the patent-office that the claims have been allowed.

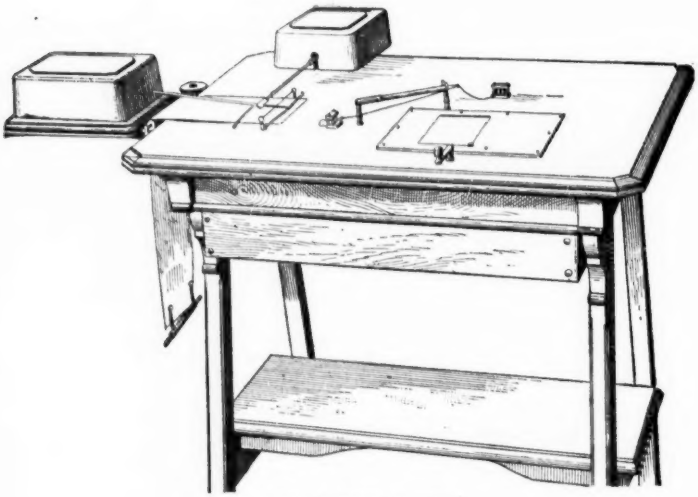

FIG. 13—GRAY'S SECOND MACHINE.*

Etheridge writing-telegraph was continuous, there being no breaks between words. To have separated the words additional electro-mechanism would have been necessary. In the Gray telautograph the receiving-pen is lifted every time the transmitting-pencil is raised from the paper, by means of an electrical device automatically operated by the sender in the act of writing. There are other devices by which the paper is moved forward as required, mechanically at the transmitter and electrically at the receiver. In the performance of these extra functions two additional wires are now employed, but it is understood that provision is being made whereby only two main line wires in all will be required to perform the various necessary functions. The use of four wires undoubtedly would be a drawback, especially in large cities and on long circuits.

*The second machine was completed in March, 1888, on the step-by-step plan. The sending and receiving apparatus were placed on one table, but each apparatus used its own roll of paper. In this instrument the pen-arms were worked by means of "gripping armatures" which were operated by impulses sent from the transmitting end. This was an extremely complicated machine, the box under the leaf of the table being nearly filled with small pieces of electro-mechanism, but arrangements were made for moving the paper and raising the pen without the aid of an operator. On this machine additional patents were applied for and granted on July 31, 1888, but Professor Gray immediately set to work simplifying the system, and in 1890 brought out the machine shown in the next figure.

A notable feature of the telautograph is that characters of any description, including plans, sketches, etc., in addition to simple writing, may be transmitted by means of it. This opens a field in which such a system might have a monopoly,—the transmission of Chinese and Japanese writing. Since the Chinese "alphabet" consists of many thousands of characters, it would be impracticable to employ such a code of signals as those composing the Morse alphabet for telegraphing in that language. There might be required for a single character, perhaps, fifty dots and as many dashes. When it is now desired to despatch a message in China, the sender imparts, in Chinese speech or writing, the substance of his message to the telegraph-operator, who refers to a code-book containing Chinese characters representing the phases most current among merchants, and transmits in English the numbers corresponding to those phrases, forwarding the numbers to the proper station. There the operator, by the aid of a duplicate code-book, re-translates the message into Chinese and sends it to the addressee,—a practice certainly not conducive to accuracy. A specimen of Chinese writing which was recently transmitted by telautograph in New York is shown in Figure 11.

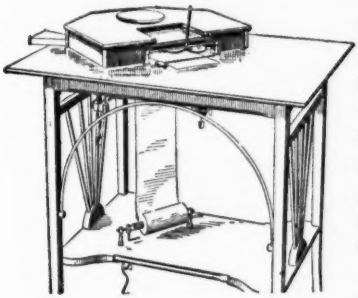

FIG. 14—GRAY'S THIRD MACHINE.*

The claim made for this system that it will not be materially affected by induction from electric-light or electric-railway circuits doubtless is well-founded. It is similar in this respect to such systems as the Wheatstone automatic and other telegraph systems in which currents of alternate polarity of considerable strength, and instruments not very sensitive to induction, are employed. The operation of the telautograph, as at present on exhibition, is quite satisfactory, and, judging by experience had with other telegraph systems, it may be said that, in the adoption of the "step-by-step" method for producing the desired movements of

*Here again the sending and receiving apparatus are combined on one table, and very satisfactory results were obtained, but owing to the delicacy of the parts and the crowding together of the mechanism the instrument was not considered good enough for commercial work, and further experimenting was commenced, which resulted in the production of Professor Gray's new telautograph.

the receiving-pen, the probability of its successful operation in actual practice is much enhanced. It is understood to be the intention of the management to establish telautograph Exchanges in the principal cities, in addition to placing the instruments in offices for "private-line" service. It is intimated that the cost of the service outside of New York city will be somewhat below ordinary telephone charges.

It is obvious that the telautograph could only have reached its present state of development after long experimenting, and by the most careful and accurate adjustment of the mechanism. Some idea of the various stages through which this invention has passed may be gained from Figures 12, 13, and 14, which represent the first, second, and third completed machines devised by Professor Gray. The first machine (Figure 12), completed early in 1887, was constructed on the variable resistance plan, but no provision was made for raising or lowering the pen, or for shifting the paper, these functions having to be performed by the receiving operator. The second (Figure 13), completed in 1888, was constructed on the "step-by-step" plan, but this was an extremely complicated machine, and on that account would hardly have been adopted for practical work in the hands of non-experts. The third machine (Figure 14) gave fairly satisfactory results, but not sufficiently so to satisfy the inventor, who persevered until the new telautograph, now on exhibition, was produced.

THE CARE OF EXISTING HIGHWAYS.

By W. E. McClintock, M. Am. Soc. C. E.

VERY few of the smaller agricultural or manufacturing towns of the United States are in a financial condition to make any extravagant outlay on their existing road-systems. It must be admitted that some very serious mistakes were made when the lines were laid out and the grades adopted; but any attempt to alter these will involve large expenditures of money, which will remove the present possibility of permanent improvement of the roadway. As a rule the roads must be taken as they are now laid out, and the roadway made hard and smooth, so as to reduce the cost of transportation and make travel more agreeable the year round.

The roadway should form a roof over the foundation. When it does, the problem is solved and good roads will be found, provided the proper care has been exercised to prevent any water from flowing under the roadway laterally. The forces which tend to destroy a road are—first, weather; second, traffic. On most of our country roads the weather has far more injurious effect than the traffic. The finer material constituting the wearing surface is crushed under the wheel to be made into mud when wet, and fine dust when dry. If the wearing surface is made of material which will crush easily, it soon resolves itself into dust and becomes worthless, and new must be put on to take its place. The smaller the fragments of the covering, the more easily will they be crushed and the poorer will be the road.

With larger fragments the softer will be more easily crushed than the harder, and with a large amount of travel it will be economy to select only the hardest and best of rocks. Very few of the natural soils are in any way suitable for withstanding either the weather or the traffic. There are localities, however, where the available funds will not permit of hauling either gravel or stone, and the best that can be done is to shape the surface with the road-scraper, to remove ruts and hollows. Where there is little money there is likewise light travel. It is well to bear in mind that vegetable loam or sods are a very poor substitute for gravel, and they had better be thrown to one side instead of being put on the

road. Little can be expected from roads built of light dirt ; but at the same time, if the side ditches can be opened to a depth of two-and-a half feet below the center of the road and graded so as to permit the water to flow freely to a point of discharge, the roads will be much better, and for most of the year, if the travel is light, they will not be bad.

The poorer the material the more care should be exercised in treating it. The great trouble with roads of this class is that they are permitted to wear almost flat, the side ditches (if any were ever built) are filled up, and what water falls on the surface remains there until it settles into the ground through the road. When the roadway is thus softened, the first wheel that passes over it will make a rut, which becomes enlarged by each succeeding wheel until the whole surface is destroyed. Another error is to give the road such an excessive crown that teams are obliged to keep in the center, which, under the extra wear, soon ruts up and is destroyed. Nothing is gained by giving the center of a road a rise of more than one foot in twelve ; and this should be an almost even rise from the gutter, and not all or nearly all at the gutter, as is too often the case.

There are many gravels that will make good roads. Some of these are made up of angular stones so mixed with a fine binding material that they pack firmly almost as soon as placed on the road and will withstand the travel for years. The banks can be readily recognized, as they stand vertically and require at least two picks to one shovel in loading a cart. There is quite a large proportion of stone in these banks over two-and-a-half inches in diameter. These should all be removed before using, or they will make a rough stony road as soon as it begins to wear. It is not safe to trust this to the man who levels off on the road, as he is more than likely to neglect his duty. It is better to screen them out and use them on some piece of road where the depth of fill will hide them entirely, covering with the screened gravel from which all stones have been removed that will not pass through an inclined screen with a one-inch mesh.

Water in any part of a road is an element of destruction, and it must not only be got out but kept out. The rain which falls on the surface of the ground soon disappears from sight to appear again in the nearest watercourse or in springs. If the ground is gravelly or sandy, it passes down to the lower impervious strata ; and if the impervious strata lie at a depth of two feet or

more, no trouble will be had with water. If clay or hard-pan immediately underlies the surface loam, the water drops to this and then flows down the slope toward the watercourse. Where the road traverses a side-hill constituted as above, trouble may always be expected unless drains are so placed as to intercept the ground-water and carry it off by a new channel instead of under the road. If the road lies partly in cut and partly in fill, it will not be necessary to build more than one drain, and that should be placed on the up-hill side. If the road passes through a section where there are no houses, a side ditch at the side or sides will serve every purpose perfectly well, the bottom to be about two-and-a-half feet below the center of the road.

Ditches should be sufficiently removed from the traveled way not to cause danger to the traveler. If the land is used in such a manner as to prevent an open ditch, a trench can be excavated under the edge of the roadway. Whenever the ground is clayey and wet, drains should be placed on each side, except on a side hill as referred to. The ditch can be dug ten to twelve inches wide at the bottom and fifteen to twenty inches at the top. In the bottom of the trench place small gravel stones about two inches deep, on which is to be laid a drain tile about five inches in diameter, increasing to larger size when a long line is to be laid before reaching an outlet. Fine gravel stone varying from half an inch to one inch in diameter are packed around the pipe, and over it to a depth of about one foot. The rest of the trench can be filled in with any large broken stone or screenings. The stone should be carefully rammed to prevent any future settlement of the road over it. The small round stones around the pipe will prevent the sand or fine dirt from passing through the joints into the pipe, while they offer no resistance to the free flow of water. The common glazed sewer-pipe is as good as any other for this purpose, and, with the bells, will make a better line than will the ordinary tile. Do not use any cement of any kind at the joints unless the drain passes near elm trees, in which case the joints lying within thirty or forty feet of a tree should be carefully cemented with good American cement mixed with sharp clean sand in equal proportions. Great care must be taken in making these joints, as the smallest hole will permit a fine root to pass in, and when once inside, where the air is warm and moist, it will soon fill the whole space. Wherever the road is wet and soggy in the spring, it is safe to say that a drain will be needed.

In building a road of rounded gravel more care must be exercised in laying it on. The best results can be obtained by screening out the fine through a half-inch screen and the coarse through a three-inch mesh. Lay on the stone, varying in size from half an inch to two-and-a-half inches in diameter, to the desired depth, and crown. Cover these with two to three inches of the fine screened gravel.

If the gravel be clean and water washed, a little soil, loam, or hard-pan will materially assist in binding it and make a smooth road in far less time than could otherwise be obtained. The additional cost of separating the gravel into different sizes will be more than repaid by the wearing properties of the road. It is almost impossible to dump ordinary gravel on the road from a cart without having the larger stones roll to the outer edge of the heap, where they make a comparatively loose foundation, while the finer stuff in the center will be firmly compacted when it drops. As soon as the road made in this manner begins to wear, hollow places will show around the original heap; water will pass easily through between the large stones, and the road soon will go to pieces. A road so built will be much better if it be rolled with a steam-roller, but it can never be a really good road.

No town's outfit for road-building is complete without a roller of some kind, and all gravel roads will last longer, wear smoother, and be generally better if they are rolled.

Where there is any great amount of heavy travel, gravel does not constitute an economical road. The first cost is less, but the repairs necessary to keep the surface even and smooth will bring the annual cost to a much higher figure than would be the case if broken stone were used. The general principles of broken-stone roads are the same now as they were when Macadam first introduced a system in the construction of such roads. With modern machinery for breaking and rolling we can obtain better results in quicker time, and less care has to be exercised in watching the road as it hardens. Many roads are built in the United States with but four inches of broken stone, which have withstood the wear of several years; but the greatest care has to be used in every detail of the construction. These roads have been constructed for the most part on a foundation of sandy loam, but none that I am aware of on clay or heavy soil. The soil was first compacted by rolling, the crown conforming to that of the finished road way. On the prepared foundation the broken stone was laid about four-and-a-half inches

thick. This was lightly rolled by passing the steam-roller about four times over it. Sand was then carefully spread over the surface as the roller passed back and forth until the interspaces were thoroughly filled to the tops of the stones. About one inch of broken-stone screenings which had passed through a half-inch screen were then laid on, watered, and thoroughly rolled until the surface became even and firm.

A second method is to spread the stone screenings on the broken stone without any sand; water, and roll as by the other method. A very thin spreading of fine gravel is at times laid on over the screenings to prevent the bond from being broken by dry weather. This is a good scheme if the road is not to be watered. Still another method of binding, which is much used with good results, is as follows: After the broken stone has been rolled, the surface is covered by a layer of screened hard-pan (mixture of sand, gravel, and clay) about one-quarter of an inch thick, and over this is spread stone screenings, which have passed through a half-inch screen. The steam-roller is passed over the surface until the finer material flushes to the surface in the shape of a fine paste, when the road can be thrown open to travel.

This is the whole secret of building a broken-stone road, when you have a natural soil that is suitable. I have referred to a sandy loamy soil as the only one on which four-inch roads have been successfully constructed. There can be found a great many old roads which have been gravelled year after year until they are solid as far as the foundation is concerned, but the gravel will not withstand the wear of wheels and the surface is usually very muddy. There are but few cases where this need be disturbed. As a rule the center of the roadway is flat and sufficiently low to allow of building up without first excavating. In this case the broken stone can be placed directly on top of the old roadway, however hard it may be, to a depth of about five to seven inches in the center and four to five inches at the gutters.

The stone should be rolled thoroughly before any "binder" be laid on, and watered and rolled again after spreading the "binder." Either of the methods of applying the binder before described can be safely used.

In case there is a clay or soggy soil the usual method is to excavate to a depth of about twelve inches. Build drains as referred to before, and connect them carefully with a watercourse or sewer. Large ledge stone should be laid with the point projecting upward

and the base resting squarely on the ground, the stones to be placed as closely together as their shapes will permit. All the spaces between the large stones must be carefully filled in with wedge-shaped fragments, carefully rammed into place. The tops of such stones as project above the required line should be broken off by hammers. A thin layer of broken stone should then be laid on over the foundation stones and rolled. The broken-stone or metalling course is then to be applied in the same manner as already described for thin macadam roads.

The few main points to be remembered are as follows :

Get all water out of the foundation and keep all water from reaching it. Secure a foundation which will not permit the road metal to pass downward under any conditions of weather. Compact the metalling so that it cannot be further pressed down by the passage of teams over it. Fill the voids of the broken stone so as to prevent water from reaching the foundation soil. Use some material for a binder which will prevent the stone from being kicked out by the horses' feet and which will be so thin as not to injure the road surface when it wears out.

A good macadam road will wear out, like everything else. Its life will depend on the quality of the materials used and the amount of travel passing over it. Where proper care has been used in selecting and building, I have known roads to last fifteen to twenty years, with very slight repairs. At the end of that time they were thin and weak and needed rebuilding. The simplest method of repairing such a road is to pick the surface up, shape to the crown desired, resurface with broken stone to the correct grade, and roll and bind the same as on a new road.

While a steam-roller will perform the work better and at less cost, yet a horse-roller will compact a broken-stone road perfectly well. A two-ton ring roller is perhaps the best to use, as the weight is upborne by all the rings when the road is loose, and on only half of them as soon as the compacting begins, thus doubling the pressure per inch at the time most needed.

While we may not be able to regulate the grades on many of the old roads, we can regulate the widths. In most cases the width is far more than is demanded by the traffic. None of the excessively traveled way is kept in good order. In the older countries the finished roadway is made but fifteen to eighteen feet wide, and this is sufficient to accommodate all the travel. The shoulders can be finished out by the use of gravel or anything that comes

most convenient so as to give a width of twenty-one feet. The crown or rise from the gutter to the center should not exceed one inch to the foot on a hill-side, and about half as much on level stretches. More than this compels the teams to keep in the center, and by continuous wear in one line to produce ruts.

The best rock for broken-stone roads is trap. It is hard, tough, and easily held in place. Schists, slates, soft limestone, and most of the gniesses are not good for road-building. With any amount of travel they quickly grind to powder to the destruction of the road. In most localities the field or bank stone will make fairly good roads, if the slates and schists are thrown out. They can be easily obtained and broken, and in most cases the land is much improved by their removal. It is good policy in setting up a crushing plant to bear in mind that each and every time the stone has to be handled it adds ten to fourteen cents a ton to the cost, and it should be set in such a manner as to save moving the stone as much as possible. If the crusher be set up so as to make it difficult for the teams to get in to load, then there will be a loss of time on the part of the teams which counts up quite rapidly and materially increases the cost of breaking the stone. In many cases it is necessary to shovel the stone away from the crusher in order to keep it clear, and this adds about ten to twelve cents per ton to the cost. A very good and at the same time cheap set-up can be had by placing the crusher on the side of a hill, accessible on one side to teams and over bins on the other. The bins should be sufficiently large to hold about one day's breaking and located to allow at least two teams to load at once. A still better arrangement than this is one in which the bins are set up high enough to allow a team to be loaded under them without shoveling.

The most economical method of setting a crusher is to place it low down, so the stone can be delivered directly to the jaws without moving, after they are once dropped. When the broken stones pass from the crusher, they should be delivered to an elevator, lifted about forty to sixty feet, dropped into a revolving screen, carried by chutes to bins for the different sizes, and loaded from the bottom of the bins by chutes or gates directly onto the carts. By such an arrangement the stone need not be handled from the time they leave the quarry to the time they are leveled off on the street.

While trap makes the best stone for macadamizing, yet it cannot at all times be obtained, and the cost of moving will be so great that a poorer grade of stone will have to be used. The hard

syenites, felsites, conglomerates, and amygdaloids will make good work. Some of these will not roll down without covering with gravel,—particularly if a steam-roller be used. The roller will break off the sharp angles ; the small fragments do not have any binding properties, and for this reason the binder must be placed on such stones before they are compacted.

On hills with a grade of more than eight or ten feet to the hundred it is difficult to place any material which will not wash during heavy rainfalls. In treating such hills I have covered the surface with hard-pan, giving it the proper crown. On this was spread about two inches of broken stone, the fragments of which varied from half an inch to one inch in diameter. After the first rain the hard-pan became very soft, and into this was pressed the stone until a firm solid mixture resulted which readily resisted the action of water and has worn but little in several years. Gravel will serve the purpose very nearly as well as the broken stone.

ELECTRICITY.

Conducted by Franklin L. Pope.

SOME of the State legislatures are committing a grievous mistake in granting charters indiscriminately to interurban electric railways, and giving them the free run of the public highways, and this without requiring them to pay any franchise tax for the privileges thus liberally bestowed. This is a policy which no State can afford to pursue, and one which is sure to ultimately result in widespread disaster. While most of the local horse railroads which have been converted into electric roads have proved very profitable investments, it does not necessarily follow that tracks can be put down on every cross-country road, and made to become bonanzas for the bondholders, merely because they are operated by electricity. It has by no means been satisfactorily demonstrated that for distances of five to ten miles, where hourly or half-hourly trips of a small car are all that the traffic requires, electricity possesses any economical advantage over steam or even over horse-power. The prevailing craze for covering the rural districts with a network of electric railways is evidently being assiduously fostered by the manufacturers of electric apparatus in order to enlarge the market for their wares, and so long as the public can be induced to purchase and pay for the bonds issued to pay for these projects enterprise and prosperity will doubtless continue to go hand in hand. "The American public"—as the astute Mr. Gould once remarked—"are fond of bonds."

RECENT decisions of the Federal courts in patent cases indicate that the distinction between an invention, properly so-called, and a structural organization which is the result of a mere exercise of the ordinary skill of the mechanic or the engineer, which distinction at best is often liable to be somewhat hazy, is becoming lost altogether. We recollect no legal decision which has gone anything like so far in this direction as that recently promulgated by Judge Green at Trenton, relating to a patent on a system of circuits for electrical distribution for lighting and power purposes. In systems of pipes for the distribution of water and gas under pressure it has for years been a common expedient, whenever the consumption in a certain district had increased to such an extent as to reduce the pressure inconveniently, or to render it irregular, to lay a new main directly from the source of supply to the center of consumption in the district affected, and thus restore the pressure to the normal average. This combination of supply-mains with direct feeders is obviously applicable in precisely the same way and for the same purpose in electric systems, but this particular application has been made the subject of a patent, a thrifty idea which certainly never could have occurred to a gas-engineer, and it is this patent which has now been held to be valid by the decision referred to. Indeed the fundamental idea was shown not to have been novel even in electric distribution, so that the novelty of the patented invention is really limited to the use of a feeder of smaller capacity than the main. Hence it might be that the use of a conductor an inch thick might be no infringement, while, if one half an inch thick were substituted, it would constitute an infringement. This is but one of the multitude of inconsistencies and absurdities which are certain to arise in practice if the courts should hereafter lend their aid to the enforcement of the innumerable brood of patents which the government has of late years granted, covering what are neither more nor less than ordinary engineering expedients, devised in the first instance to overcome such difficulties as continually present themselves in every-day work. The same amount of invention is displayed by any

man who, when he finds his water-supply insufficient, puts in a larger pipe. In fact, we know of one patent relating to electrical distribution, taken out by an electrical engineer of wide reputation, in which the "invention" claimed consists in making the sectional area of the conductors in different portions of the system proportionate to the volume of current they intended to carry. We shall doubtless hear of this last-named patent again ere long, in case the court of appeals should sustain the decision of Judge Green.

IT has been observed by Dr. Edward Hopkinson that it is well for the electrical engineer to be constrained from time to time to contemplate the proportion between the amount of energy available for his final purposes, as compared with the coal energy with which he starts. In the matter of transportation, for example, beginning with the familiar 12,000,000 foot-pounds of energy known to exist in a pound of coal, and making use of the most approved economical appliances now available in the art, we have a series of cumulative losses in the boiler, engine, generator, conductors, and motor, as well as in the dead weight of the vehicle, until we finally arrive at the energy expended upon the passenger himself, which we find to be approximately 133,000 foot-pounds, or a little more than 1 per cent. of the energy with which we set out. But even this is a more economical process than that of illumination by the incandescent lamp, in which the final energy rendered available does not exceed half of 1 per cent. Nothing that has been accomplished in the past in respect to the transformation of energy can for a moment be compared with the possibilities which the future holds in store for mankind.

THE employment of the magnetic separator enables a large portion of the native phosphorus to be eliminated from iron ore before it goes to the blast-furnace. This makes it possible to produce a grade of steel having a high percentage of carbon and an extremely low percentage of phosphorus. Such a steel, owing to its remarkable toughness, can be rolled at a low temperature, and it therefore makes a very superior quality of rails. Nearly 100,000 tons of such rails have been put into service on the principal railroads of the United States within the past three years, and it is stated on good authority that up to the present time not one of them has been broken in the track by ordinary usage.

THE electric elevated railroad of the World's Fair is 3.10 miles long, and has a double track with loop terminals. There are 10 stations, each of which is designed, so far as possible, to be approached in each direction by an ascending grade, which is expected to materially economize the cost of operation. The principal electric generator is a 1 500-kilowatt multipolar, undoubtedly the largest machine of the kind in the country. The armature shaft is of steel and weighs 65 tons. It is driven by a 2000 horse-power cross-compound condensing engine. In addition to this monster machine, there are three 500-kilowatt generators, and a smaller one of 200-kilowatts, with a corresponding equipment of engines and boilers. The entire engine and dynamo plant occupies a room 140 feet by 87. The rolling stock consists of eighteen trains of four cars each, the first car in each train being equipped with four motors. The nominal horse-power of the motors is approximately 530 for each train. Each car is forty-seven feet long and seats ninety-six passengers. The electrical conductor is a line of 60-pound steel rails, placed outside the traffic rails. The round trip, including stops, is made in forty minutes, and the trains can be run, if necessary, under two minutes headway.

AN electric plant has been erected at the World's Fair for charging the storage-batteries of the electric launches which are to ply on the lagoons, having a capacity sufficient to charge simultaneously sixty launches containing seventy-eight cells each. It is large enough to light a town of 10,000 inhabitants. Another interesting application of electricity to navigation will be a line of electrically-lighted buoys, ex-

tending from the Exposition landing to the foot of Van Buren street, which will make night navigation on the lake safe and easy. Each buoy will carry an arc-light of 2000 nominal candle-power. Electrically-lighted towers 125 feet high will also be placed on each of the piers, at the terminals of the route.

A DISCOVERY which promises to be of great importance in the arts has recently been made in connection with the electro-deposition of copper and other metals. Heretofore these processes have been carried on by immersing the metal intended to receive the deposit in an aqueous solution of a salt of the metal to be deposited. The new process makes use of insoluble salts of the various metals, which are reduced to fine powder and mechanically mixed with water. The mixture is applied to the surface of the metal by means of a brush to the handle of which is attached the electric conducting wire, so that the process of deposition resembles that of applying a coat of paint. Not only pure metals, but all sorts of alloys are applied as coatings to other metals with the utmost facility by this process. The hull of an iron ship, for example, may be painted over with a tough, adherent, and impervious coating of metallic copper, of any desired thickness. Experiments have been made which indicate that this process may be successfully applied to the plating of aluminum with silver or gold, a desideratum which has long been sought for, but hitherto apparently in vain.

THE prospectus of the Chicago and St. Louis Electric Railroad Co. reads like a travesty on the story of the speculation in hens projected by Euphemia, the young matron of Rudder Grange. Beginning with ten hens, and allowing every reasonable margin for losses, she expected to have sixty hens at the end of the first year, 360 the second year, and so on, until at the end of five years the number should amount to 64,800, which, at 75 cents each, would net her $48,600, a sum beside which the petty cost of a fence and a few chicken-coops was wholly unworthy of consideration. It has always been impossible for electrical men to look at the Chicago-St. Louis project seriously. We are informed by the prospectus that the undertaking is "in the main founded upon that which has actually been accomplished." We should say, rather, that the value of its stock was founded, like that of a certain telephone-syndicate which gathered in a goodly lot of shekels within the memory of many persons now living, "upon the future possibilities of electricity." The undertaking itself does not appear to be founded upon anything unless it is human credulity. The prospectus is a tissue of glaring absurdities, and in criticising it these seem so numerous that it is difficult to know where to begin. Yet as the slang phrase is, in these days "everything goes", if only it be labelled "electricity"; hence no one appears to see anything queer in the offer to sell a stock alleged to be certain to earn 29 per cent. per annum, at 60 per cent. of its par value.

IN a paper read before the London Society of Civil Engineers Dr. John Hopkinson gave some interesting statistical information respecting the operations of the South London underground electric railway. The engines average 230 indicated horse-power each, which is almost exactly one-half full load. The combined economical efficiency of the engines and dynamos is 78 per cent. at full, 70 per cent. at half-load, and 65 at quarter-load. The loss of energy in the feeders is exactly equal in value to the interest on the prime cost of the feeders, which is the condition of maximum economy. The coal consumed averages from 35 to 40 tons per day. Miles run in 1892, 214,417; passengers carried, 3,317,602. Cost of working generator station, including wages, renewals, and repairs, 4.59d per train mile, and equal to 1.56 per kilowatt. The locomotives weigh 10 tons, of which 6 tons is motor and the rest frame. It may be observed that the elevated railways in New York carry more passengers in thirty days than the South London line did during the whole year,—a fact which we mention merely to show the magnitude of the rapid-transit problem which New York,

and in a lesser degree several other American cities, have pressing upon them for solution.

IN a recent paper on the commercial efficiency of transformer distribution M. Picou, a French engineer, points out that, while the alternate-current transformer, considered by itself, is an excellent piece of mechanism, its all-day efficiency, as ordinarily used, is comparatively low. Of the 5 per cent. of loss which occurs at full load, more than half is due to the iron, and is a fixed quantity at all loads, while on the other hand the loss in the copper varies as the square of the current. The conclusion is that the apparatus should be so arranged that the iron and copper losses for the average current shall be equal. It is certainly no easy matter to ascertain with certainty just where the losses take place in a system of alternating distribution through transformers, but that such losses may amount to an aggregate little short of appalling is shown by some of the experiences recently published in the technical journals in this country and abroad.

ONE of the largest paper-manufacturing concerns in the United States is putting in a plant for bleaching all the wood-pulp used by means of electricity.

A TWENTY-FIVE-FOOT motor freight-car has been placed on the electric street railway between Rockland and Camden, Maine, a distance of about ten miles. The car weighs 15 tons, and has a carrying capacity of 20,000 lbs., but can pull an ordinary freight car in addition if required. The trucks are fitted with four 50 h. p. motors, on account of the severity of the grades, which are such as to preclude the profitable extension of steam service over the route.

THE annual report of the street railway system of Albany shows that the gross earnings for 1892 are nearly double what they were for 1891, while the net earnings are $42,774 as against $23,328. This is mainly the result of the substitution of electric for animal power, in a locality in which the grades are exceptionally severe, and the travel at times very heavy.

A WRITER in *Industries* complains loudly of the want of a good book on telegraphy. He thinks there are an abundance of so-called "practical" manuals, but that what is lacking is a treatise on the theory of the subject. "We doubt," he says, "if any work on telegraphy exists in which, for example, an explanation of a relay is given which would enable an electrician to design one to work with a given current and a given internal resistance." We think that this complaint is ill-founded. There is more than one work, not alone in English, but in other languages, which contains this, and much other information of the same general nature. Moreover, it must be remembered that for every person who needs to know how to design a piece of telegraphic apparatus there must necessarily be at least a thousand who need to be taught how to adjust and operate it to the best advantage. The great trouble is that the modern telegraphic employé does not care to study any scientific books at all, even the simplest and most elementary. We doubt if it would be possible to sell in this country to-day a hundred copies of a work treating solely on the theory of telegraphy, without reference to its practical aspects.

IN a lecture before the Society of Arts in London Professor George Forbes said that no system of electrical distribution could be considered as final which did not provide for electric motive-power, illumination, and storage. A combination of the various systems in use seemed likely to be evolved, combining the advantages of high-pressure alternating transmission with low-pressure continuous current distribution, suitable both for storage and for motive power.

THE British householder seems to be a queer bird. The London *Electrical Review* remarks that the electric-lighting companies which have undertaken to exploit the residential districts have been far less successful than was anticipated. The

householder had his house wired and the lights installed, and then it appeared that the height of his ambition was to keep his electric-light bills as small or smaller than his gas-bills. Consequently he has staid at home every evening, and devoted his time to following the servants around to make sure that all the lights were turned off as soon as they were no longer needed. This was by no means satisfactory from the point of view of the central-station man's load curve, and so the companies, it seems, are holding on, and waiting with as much patience as may be for the householder to get tired, so as to permit the load curve to rise.

THE silly assertion is made in a leading financial journal that the failure of the storage-battery to secure adoption in this country is due to the opposition of the General Electric and other large electrical companies, on the ground that its general introduction will render antiquated and worthless an enormous electrical plant, constructed at high cost. It is charged that these great companies miss no opportunity to purchase all the storage-battery patents that make their appearance, not for the purpose of affording the public increased facilities, but with a view of perpetuating the hated trolley system. Such a policy is animadverted upon in severe terms, as being "penny wise and pound foolish." We should say it was.

THE Edison Electric Illuminating Company of New York report the total installation of incandescent and arc lamps and motors, up to January 31, as equivalent to 202,000 16 candle-power lamps.

A NOTABLE telegraphic feat has been performed by the Direct Cable Co., in transmitting the result of the Oxford-Cambridge boat race to this country in thirteen seconds, this being the actual time occupied in obtaining the news at the course, forwarding it through London and across the Atlantic, and delivering it in the office of the United Press in New York. The cable service has been brought to an admirable state of efficiency on all the transatlantic lines, and it is seldom that even an ordinary commercial message occupies more than ten minutes in transit.

THE great electric-power transmission-plant at Pomona, Cal., heretofore mentioned in these notes as in course of construction, is now in successful operation. The generators are driven by direct-coupled Pelton wheels, under a head of over 400 feet at 600 revolutions per minute, and each generator delivers alternating current at a pressure of 1000 volts to a bank of transformers, by which the initial pressure of the line is raised to 10,000 volts. Circuits of bare copper wire, carried on special insulators, extend to the towns of Pomona and San Bernardino, the latter being twenty-eight miles distant, where the power is being utilized for lighting and other purposes.

EXPERIMENTS are now in progress looking to the application of the trolley system to the propulsion of boats on the Erie canal, referred to in these notes some months ago. The locality selected for the first trial is the section between Albany and Troy. There is no reason to doubt the entire feasibility of the plan, if its execution is placed in the hands of competent persons.

IN another part of this magazine is given at length an account of Professor Gray's telautograph, which has been successfully exhibited in New York during the last month. It would seem somewhat problematical whether the want which this apparatus is designed to supply really exists to an extent which will make it profitable to its ingenious inventor. At first sight the employment of such a system would appear comparable with a proposition to abandon the typewriter for business purposes and go back to the time-honored pen. But it is nevertheless not difficult to imagine cases in which the possibility of the reproduction of a holographic communication at a distance might be of almost inestimable service.

MECHANICS

Conducted by Leicester Allen.

PERHAPS nothing indicates the enormous strides mechanical progress is making throughout the world so much as the almost complete revolution effected in methods and means of naval warfare during the last three decades. Nowhere has the advance been more conspicuous and overmastering than in the United States. Comparatively few, even of the best informed classes of our citizens, have realized the extent of this change wrought in the brief period named, and particularly the fact that the greater part of it has been brought about during the last eight years, a period of almost profound peace with all the world. It has been said that the history of war is also the history of civilization. It might be said with as much truth as usually inheres in generalizations of this kind that the history of naval progress is the history of mechanical progress.

If in writing this history an author should seek to divide it into epochs, it could scarcely be otherwise than that the last and grandest epoch of all should have its beginning placed contemporaneously with the first conversion of the reciprocation of a piston in a steam-cylinder into the continuous rotary motion of a crank, through the auxiliary appliance known as the fly-wheel. From this union sprang modern mechanical possibilities.

The complimentary dinner given to the retiring Secretary of the Navy, the Hon. Benjamin F. Tracy, by the Hamilton Club in Brooklyn, on the evening of March 16, was, on two accounts, a remarkable occasion. First, there were present the two great secretaries under whose administrations the naval progress of the past eight years in the United States has been accomplished, one being the Hon. William C. Whitney, his predecessor in the office. Second, the extent of this progress, as set forth in the speeches of these two able men, was never before so comprehensibly and forcibly presented to the American public. From these speeches, especially that of Mr. Tracy (which, by the way, did full justice to the advances made under Mr. Whitney), it may be learned at what a rapid pace our navy is overtaking other famous navies. When Mr. Tracy made his first report in December, 1889, he stated "that, when all the ships which had been authorized up to that time should have been completed, the United States would still rank as the twelfth naval power." But in the speech alluded to he said:

> But such is not the condition of the United States to-day. When the ships now in the course of construction are completed, we will rank as the fifth naval power, surpassed only by England, France, Russia, and Italy. We shall have passed both Spain and Germany, and can once more take rank among the naval powers of the world.
>
> I am aware that this is the first public announcement of our superiority to Germany, but the statement is made not unadvisedly, but after careful comparison of the two navies ship by ship. From such comparison it appears that with the ships which constitute the fighting-force of the two governments the United States can throw in any one direction, at a single discharge, 31,000 pounds of metal against 25,000 pounds by Germany. In speed and efficiency our cruisers far surpass those of the German navy.

In four years, therefore, the navy of the United States has advanced from the twelfth to the fifth rank among the navies of the world; and as this advance has been entirely dependent upon mechanical construction *in our own country*, it indicates a state of the mechanic arts that places us, as a nation, in the very van of progress. New industries have also been developed and brought into perfect working order as the result of the effort to strengthen our

means of naval defense. Again Mr. Tracy says:

The great progress we have made has been achieved not so much by the number of ships we have built as by their greater power and efficacy. Ship for ship, there is nothing in the world that is superior to the ships of recent American design and construction. It is not only in the type and construction of ships that progress is to be noted, but in certain auxiliaries that go to make up a naval force.

Four years ago we had ships which had been constructed for the use of torpedoes, but we had no torpedoes nor had we any means of producing them; but to-day Brooklyn is producing as good torpedoes as are manufactured anywhere in the world. The plant is not yet two years old, but the success of the enterprise is already assured.

But the greatest progress made in any one direction has undoubtedly been in the production of armor. For twenty years it has been a conceded fact that the gun could beat the armor, but we have reversed this and have succeeded in producing an armor-plate that can beat the gun. The nickel-steel armor-plate Harveyized cannot be pierced. Every projectile that has been fired against it has been crushed into small pieces. You may break it, but no projectile can get through it.

The production of this armor has made the armor now on all English ships so inferior as to be practically worthless.

The nickel-steel Harveyized armor is an American production which every naval power in Europe is now preparing to adopt. The production of this armor is undoubtedly the most important event connected with my administration, and for which it will be the longest remembered.

SPEAKING of fly-wheels, there have of late been numerous instances of bursting fly-wheels; and this class of accidents appears to be on the increase. The conditions of working have been changed, particularly in the matter of running speed. Large fly-wheels—diameters fifteen feet and upward—are now run at peripheral speeds of from 80 to 120 feet per second, at which velocity the centrifugal strains are very great. Frequently it is found, when fly-wheels burst, that flaws in the castings have existed, originating in the foundry where they were made. Such flaws indicate that methods of founding need looking into with reference to the improvement of fly-wheels. As any desirable degree of strength is attainable in a built-up wheel, it might be advisable to abandon former methods in favor of some new construction for fly-wheels of large diameter, running at high peripheral velocities.

ALUMINUM is gaining a place among industrial metals. Lately there has appeared in the show-windows of fancy goods stores a variety of articles made from aluminum. In appearance these goods are little, if any, inferior to silver articles, and they are less liable to tarnish from the action of sulphur gases. The metal is well adapted for numerous things in common use, such as pocket match-safes, cigar-cases, pencil-cases, and even watchcases. It will be more and more used for these and other purposes as time advances. One of the disabilities that has prevented its more rapid introduction into various industries has been the lack of suitable solders for joining it after it has been reduced to required forms. Among others who have been studying the applicability of different solders for aluminum working is M. J. Novel, who has recently published several recipes for white solders suitable for the pure metal, and yellow solders for aluminum bronze. Some recipes for white solders are as follows: (*a*) Pure tin 1000 parts and lead 50 parts; melts at 536° to 572° F. (*b*) Pure tin 1000 parts; pure zinc 50 parts; melts at 536° to 612° F. The last-named solder is recommended for jewelry and other fancy articles. Light yellow solders are: (*a*) Tin 1000 parts; copper 10 to 15 parts; melts at 662° to 842° F., according to amount of copper used, and makes a much stronger union than the white solders. (*b*) Tin 1000 parts; nickel 10 to 15 parts; melting-point, 662° F. to 842° F. A good, strong union can be made with this solder. A deeper yellow alloy for soldering aluminum bronze consists of tin 900 parts, copper 100 parts, and 2 to 3 parts bismuth. The shade of yellow can be varied by varying the amount of copper between the limits

given. Altering the proportion of bismuth within the limits named varies the melting-point so that the solder is suitable for use not only with aluminum bronze, but for joining aluminum to copper, brass, zinc, iron, or nickel.

AMONG the many innovations in mechanical operations and methods that electrical engineering has opened a way for that of melting and casting metals in exhausted chambers through the aid of the electric current is one of the most curious and interesting. The method is called the Taussig process, after its inventor, Professor Taussig. A recent exhibition of this process by its inventor, in the casting of a model propeller, is described in *Industries* (London), from which the following description is condensed:

The iron furnace consisted of a rectangular vessel 6 feet by 3 feet by 3 feet. Two electrodes, apparently of wrought iron, were placed upright inside the furnace, so that their surfaces, of 8 inches by 4 inches, faced the arc-shaped piece of iron which was to be fused; a channel of clay served the purpose of conducting the fused metal from its clay melting bed into the empty clay mold placed at a lower altitude in the otherwise empty iron furnace. The wires connecting the flat metal electrodes with the generating machinery were already in position, as was also the exhaust pipe connecting the furnace with a steam air pump of about 20 horse-power, which also drove the dynamos. The 30 lbs. of pig-iron in the clay bed having been placed parallel with, but a few inches in front of, the flat electrodes, the cover of the oven was swung on; the necessary exclusion of external air being effected by india-rubber pads fastened to the furnace cover. The cover being fastened down, and the pump set working, the currents were switched on at the same moment. The indicator on the exhaust-pump soon showed an exhaustion of 92 per cent. of air. The electric indicator showed respectively 2500 to 3000 amperes and 2 to 2½ volts. The gradual approach from red to white heat could be followed from the eyelets in the furnace. Fusion was obtained in 8 minutes, the indicators showing great uneasiness until the resistance had been reduced to nil by the current being allowed to pass freely through the fused metal. In 14 minutes the furnace was opened, and a minute or two later the clay was chipped off and the perfect cast of a propeller was exposed to view.

Just how far-reaching in its effects upon mechanical operations this innovation may prove it would be rash to predict; but to an imaginative mind it appears to open an almost inexhaustible vista of possibilities.

IN this department recent mention has been made of the extension of the range of temperatures, both positive and negative, lately found possible to be maintained, and of the extension of knowledge of the physical and chemical qualities of materials this is likely to effect. Mention was also made that at the low temperatures now attainable common air condenses to a liquid under ordinary atmospheric pressure. Since the previous writing alluded to Professor Dewar has communicated to the Royal Society the announcement that he has succeeded in congealing air to a true solid form. The details of these remarkable experiments of Professor Dewar would be out of place in this department, although they are of intense interest in themselves. The opinion expressed in the former mention of investigation lying in the direction of low temperatures, that the metallic or non-metallic character of hydrogen might ultimately be determined by reducing it to a solid state, seems now all the more likely to be soon confirmed. The long suspected part that this substance plays in metallurgic phenomena, if once definitely ascertained, might prove of immense value in all mechanic arts wherein metals are the principal materials employed.

PROFESSOR S. P. LANGLEY'S steam-engine, designed for the flying-machine upon which he has been so arduously working for about two years, seems a paragon of scientific construction for the attainment of a specific purpose. That purpose was to obtain the lightest pos-

sible working steam-engine in proportion to power developed. The minimum of weight seems to have been obtained, however, only at a maximum of cost. These points of Professor Langley's engine are referred to in Professor Thurston's excellent articles on "Progress in Steam-Engineering," the first of which appears in the present number of this magazine. The most interesting of the innovations in this machine (doubtless to become historical in the literature of aero-navigation, to which Professor Langley has been one of the most important contributors) is the substitution of a hydrocarbon, probably naphtha, for water in the boilers; the vapor of this liquid to be used in the engine cylinders in the same way as steam is used in ordinary steam-engines. The boilers are of copper, and the fuel is said to be gasoline.

As to the flying-machine itself, it may or may not meet Professor Langley's expectations; but those who have hastened to predict a failure are reminded that the experimenter is a man of no ordinary type. With the highest scientific attainments, he possesses great skill in practical construction, and is the last man one would expect to deceive himself in a matter of this kind. His writings upon the subject of mechanical flight evince a depth of insight into the principles involved scarcely equaled by any other investigator, and previous work in astronomical observation has disciplined his mind to minute scrutiny of all that relates to any line of investigation he may enter upon.

The machine is described as being fish-shaped, with crescent-shaped aero-planes, the material of which is a groundwork of steel covered with silk. Several small propellers will be used to drive it, and the engine driving these propellers is stated to develop one horse-power for five pounds weight in the motor, a result hitherto unprecedented. Were there nothing else in Professor Langley's work to render him famous, this achievement is enough to arrest the attention of the mechanical world.

A DREDGING-MACHINE of such proportions and capacity as undoubtedly entitle it to be considered the largest and most powerful machine of its kind in the world has been recently launched at Barrow, England, at the shipbuilding yard of the Naval Construction and Armaments Co. It is a twin-screw, hopper and sand-pump dredger and has been christened *Brancker*. It is to be used in removing the Mersey bar so that the steamers of the largest tonnage may enter that river at low tide. The machine is claimed to be able to fill the *Brancker's* hoppers to their full capacity, 3000 tons of sand, to proceed to the dumping ground, discharge the load, and return to the bar all within a single hour. For a day of ten hours its capacity is therefore 30,000 tons, an amount of work probably never before performed by any single dredger of this or any other type.

THE great clock of St. Paul's church in London must be a remarkable piece of mechanism. The *City Press* (London) complains bitterly of the vandalism that has led to the removal of this clock and the substitution of a modern tower-clock for it. It says the old clock, "which was put up by Langley Bradley in 1708, is in splendid condition and might to all appearance go on for another two centuries without failing to bear accurate record of the passing time. It is a grand old clock, remarkable for the magnitude of its wheels and the fineness of its works. It cost £300 to build. Its two dial plates are 51 feet in circumference, and the hour numerals 2 feet 2½ inches in height. The minute hands are 9 feet 8 inches long and weigh 75 pounds each, and the hour hands are 5 feet 9 inches long and weigh 44 pounds each. The pendulum is 16 feet long. It is an eight-day clock, striking the hour on the great bell, which is suspended about 40 feet from the floor. The head of the hammer weighs 145 pounds and the clapper 180 pounds." Think of a machine like this running night and day for two hundred years and still in fine working order. One would suppose the customary reverence for ancient things in England might save the degradation that awaits this masterpiece of the horologic art.

around which cluster so many historical, poetical, and literary associations.

THE United States timber-tests, of which mention was made in this department at the time they were initiated, and from which much valuable information was expected to be obtained, appear to be embarrassed by the neglect of Congress to make suitable appropriations for carrying them out. The following communication shows the exact status of the matter at the present time :

Mechanical Editor ENGINEERING MAGAZINE :

Although all the leading railroad engineers, architects, professors of engineering, and others interested in the timber-tests had flooded with hundreds of letters their representatives and senators and the committee on manufacturing in whose hands the special appropriation for the United States timber-test work was pigeon-holed, neither the committee nor the house paid any attention to this expression of public interest. The senate, however, realized that there was value in the work and sincerity in its endorsers, and increased the appropriations for the Forestry Division by $8000; that is, 20 per cent. of the amount asked and considered by those in charge as necessary to continue the work on a proper business basis. Under the circumstances the testing will be discontinued until after July, when the new appropriations become available, and then proceed at the slow pace which Congress has set.

Although the result of the efforts of those who took active interest in securing appropriations for the work were not crowned with that success which they deserved, this is the only proper method of influencing legislation, and those interested in the investigation should not fail to move again when the new Congress assembles.

The first complication of test results is now in the hands of the printer and will probably be issued within six or eight weeks as " Bulletin 8, Timber Physics, Part II." It will contain the results obtained on longleaf pine, and will especially discuss in detail the results of tests and examinations of bled and unbled timber, results which in themselves justify the expenditure by the government of money on such work.

The Forestry Division will exhibit the methods pursued in this work at the World's Fair, which will be of interest, since nowhere in the world has such a comprehensive and systematic investigation of timbers ever been devised. The working plans for a similar undertaking by the Prussian government have only just been perfected.

Another exhibit of interest to railroad engineers and those interested in reducing forest waste will be a collection of the most approved types of metal railroad ties.

B. E. FERNOW.

Regarding these tests as among the most important experimental work yet undertaken under government auspices, it is hoped that such a pressure will be brought to bear upon the next Congress as to secure all needed appropriations for the vigorous and thorough prosecution of the work.

IT is said that Herr Krupp, the famous manufacturer of heavy guns, is carrying out a series of experiments on an entirely new line, the use of mixed coal-dust and atmospheric air in motor engines to develop mechanical power. Such mixtures burn with explosive violence, and produce in an engine cylinder an effect entirely analogous to similar explosions in gas-engines. The production of ashes by the combustion is a difficulty which has to be overcome; but it is said that the distinguished experimentalist expresses entire confidence that the removal of the ashes can be practically accomplished, and that, while in the use of coal for generating steam only a small part of the heat can be converted into power, the direct use of fuel in an engine cylinder may result in the utilization of perhaps 80 per cent. of the mechanical equivalent of the heat. It would seem that the prevention of cylinder and valve cutting from the pressure of gritty matter always present in coal ashes would be a most difficult problem to solve in carrying out the proposed scheme, and that anything like good lubrication of the working parts in and connected directly with the cylinder would scarcely be possible. If Herr Krupp should succeed in mastering these and other practical difficulties that will readily suggest themselves to a mechanical mind, he will add much to the honor in which, as a mechanical engineer, inventor, and business organizer, his name is now held throughout the world.

A REVOLVING grand-stand for race-courses is among the newest of mechanical inventions; and, as it caters to a widespread passion for a sport numbering a large proportion of the public among its devotees, it seems likely to come into popular use. It enables its occupants to see accurately and successively all parts of a race-course, and, without change of position, to keep the horses in view in all parts of the race. The stand is made to float on the surface of water contained in a circular basin, and is slowly turned by mechanical power under control of an operator, who thus can make it face the horses from start to finish. Any one who has experienced the uneasy interval of suspense during the time when the horses in a race are out of view—generally somewhat more than half the circuit—can appreciate the additional pleasure and relief this invention might afford. There appears to be no limit of size beyond which such a stand would become impracticable, since its buoyant power can always be made proportional to its seating capacity; and its turning, no matter how large, can be regulated with facility. The stand can be so placed with reference to the wires that the most interesting events of the race, the start and the finish, can be closely viewed. When the future historian shall write the story of engineering as applied to amusements in the twentieth century, this device will probably be one of the things to be recorded; and when so many years have been snowed upon the record as to render it classical, as are existing accounts of ancient Greek games and Roman chariot races, like the ruins of the Colosseum it may make an attractive picture in text-books of a future age.

A COMPARISON of forced and natural draught for marine boilers has been made between the steamships *Adirondack* and *Alene* in the West India trade, by their owners. A gain in economy of 20 per cent. is claimed for the forced draught. *The Engineer* (London), with reference to these and other similar tests, says that two years ago Messrs. Denny and Co. built two steamers for the British India Steam Navigation Co., the *Vadala* and *Virawa*. These ships are alike in all particulars except boilers. The *Vadala* has two double-ender boilers with eight furnaces, three feet seven inches in diameter. The *Virawa* has two single-enders with Howden's forced draught, and four furnaces three feet seven inches in diameter. Both have been working in the eastern seas for two years. In making comparisons of economy great precautions have been taken, even to changing engineers from one ship to the other. Messrs. Denny & Co. now report that "the *Virawa* performs the same work as the *Vadala* on fifteen per cent. less fuel. The coal used is, to a large extent, Bengal coal. This comparison, it will be noticed, is giving the natural draught the advantage in large boiler power, as the *Vadala* has eight furnaces 3′ 7″ diameter against the *Virawa's* four 3′ 6″ furnaces 3′ 6″ diameter." Besides greater economy, the *Virawa* has maintained a higher average of speed than the *Vadala*. With reference to a voyage to the West Indies in the *Alene*, one of her owners is stated in the *The Engineer* to have reported that he considered forced draught as indispensable for their trade, as by it a steady speed of twelve knots can be maintained with ease under all conditions of atmosphere, and that, instead of men sweltering in the stoke-holds in sultry weather, trying to maintain steam as in natural draught steamers, the stoke-holds were the coolest part of the ship. He reported, also, that "there was not a particle of dust or soot on the deck of the ship," a condition of things the very opposite from what he had been led to expect from the use of forced draught.

ARCHITECTURE.

Conducted by Barr Ferree.

THE work of Frenchifying American architecture goes merrily on. Within the past year one eminent professor of this art was scarcely dead, and certainly not buried, before urgent calls were sent to Paris for a successor. Every year crowds of draftsmen flock to Paris, spend a year or so in the Ecole des Beaux-Arts and return to their native land deluged in a veritable bath of Parisian atmosphere and art. No one has yet attempted, we believe, the full ten years' course, but the first student who shall do so must be near at hand. Our architectural schools and professors lose no time in teaching, as best they may, the Parisian system, and then sending their students abroad in order that they may really learn something. If a more significant commentary on this strange fascination were needed it may be found in the fact that none of the leaders in this movement have so much as set foot in America, and all the tremendous energy that our students are expending in this direction is so much vitality wasted. Architecture has only really flourished when it has responded to the conditions under which it has been produced. It has been reserved for the American people, in the last decade of the nineteenth century, to undertake the reversal of a method in use since the world began, and develop an architecture based, not upon the essentials of the problems, not upon the conditions and circumstances under which buildings were produced, but upon the ideas of a body of foreign architects who have reduced the art to a science and know nothing out of their academic vocabulary. It is quite to be expected that the Americans who have studied at the Ecole des Beaux-Arts should wish to keep its memory green by the formation of a club. This is quite their right; but when they go beyond this and undertake to urge other draftsmen to study abroad they invite general criticism. Such a club has just been organized in New York, and marks a fresh stage in the amazing French enthusiasm which characterizes American cultured architecture. As a sign of the times it is interesting; as an indication of the possible future of American architecture it is expressive of the deepest gloom.

We would not be misunderstood. We are quite aware of the merits of the Ecole des Beaux-Arts. We admit that its American students have accomplished great things for American architecture, but this has been because the fire of architectural genius burned within them, not simply because they passed through the French architectural mill. Architectural draftsmen in America are not apt to consider this, nor are they willing to take into account the manifold demerits and disadvantages of the French system. Paradoxical as it may seem, it is nevertheless a fact that though Paris possesses the foremost architectural school in the world, French architecture is of all others the most frozen, the most academic, the most stationary. The magnificent *projets* with which the time of its students is largely occupied are pure fancy sketches, never erected and never intended to be erected, unless, perchance, some foreign country holds a World's Fair and a particularly-striking design is pressed into service for some strange purpose. And in this crystalization of architecture—for such is the logical result of the French system—lies the danger, the unadaptibility, and the absurdity of its employment in America. American architectural conditions are very new. Never before in the history of the art were conditions similar to those we meet every day presented for solution. Not only are our conditions new, but they are varied and difficult. Under such circumstances any form of architectural work or practice that tends towards crystalization should be

avoided at all hazards. Neither French architecture nor American architecture has yet reached a point where it can afford to stand still and invite the rest of the world to inspect its excellencies. The French doubtless think they can do this, and may, perhaps, be left to settle their own position, but Americans cannot afford to be thus blindly led. What would be said if any one to-day were to start to teach Egyptian architecture to American draftsmen? Or East Indian or Central American architecture? The most secure and deeply-padded cell of an insane asylum would scarcely be considered safe for such a person. Almost as absurd is the conception—if one can conceive it—of the Greeks practicing Egyptian architecture and seeking to reproduce its forms. We know indeed that the Greeks obtained many forms from Egypt, but they gave up the study and reproduction of Egyptian architecture in a prehistoric age. Yet in this enlightened time we find very intelligent men imagining that they are perching themselves upon the loftiest pinnacle of architectural discernment in recommending Americans to go to Paris to learn architecture. It is a foreign transplation, pure and simple, and cannot be called anything else. The danger of this foreign study is that our architects cannot break themselves from it. The forms are so thoroughly part of the system that one cannot be learned without the other. And hence the origin of many strange applications of French ideas to American conditions.

NEVER has there been such a sharpening of lead pencils, such a getting out of drawing-boards and of drawing-paper, such a cleaning of instruments and drafting preparations generally, as during the past month. Our students from the Ecole des Beaux-Arts, wearied with designing $8000 and $10,000 cottages and houses, after a training in the most elaborate architectural schemes the human mind has conceived, have at last found something worthy of their genius and their abilities. New York has instituted a competition for a new City Hall; all the young men—and some not young as well—recognize in this a direct interposition of Providence, in providing a way out of their present state of mediocrity to that glorious and perilous height on which Fame rests, ever holding out crowns of laurel wreath for the fortunate individuals who climb up to her. And the sensation is not a wrong one. It is a great opportunity, and no one can be censured for taking advantâge of it. In many respects it is the greatest opportunity yet offered to architects in America. No American city has a municipal building which can in any sense be termed first-class. Many of them are old structures, built before the present revival of architecture and at a time in which American architects were quite unfitted, either by training or by experience, to undertake great and lasting work. Even the most recent structures of this sort are wanting in the element of greatness, an indispensable adjunct of grand architecture, though a number of them possess many admirable merits. The New York competition is, therefore, especially welcome. Not only is that city the richest in America, but its emphatically metropolitan character gives the proposed new building unusual significance. It is true that the sum at present designated as the total cost,—$4,000,000,—is not large, all things considered, but in a fair and just competition, such as this promises to be, there is every reason to look for an important and notable building. It is true that the Press of New York does not think so; a new municipal building in the City Hall park has been a possible bugbear before its eyes for many years past, and it is not likely to look with favor upon any structure which will deprive its own buildings of their present extraordinary amount of light and air, and thus, in a measure, operate as a disturbing element in the large incomes derived from that source. But as the new structure is not to advance beyond the line of the present building, the People—newspaper word for tramps, bums, and similar worthy citizens—will still have all the space they have at present for rest and relaxation. And in its unselfish and public-spirited advocacy of the rights of the People the Press will have this balm

for its injured feelings. It certainly is not to be despised.

In the Hotel Waldorf New York has certainly the most magnificent hotel in the world, and a building that surpasses many European palaces in the richness of its appointments. Certainly no other building in this country, public or private, surpasses it in magnificence of appointments, in elaborateness of decoration, in costly splendor of detail. It marks an epoch in American life not only in the extent in which the decorative arts have been pressed into service, but in expressing the luxury and magnificence which American people are beginning to require on every occasion and under every circumstance. Admirably planned, with a wise and economic employment of space, given a monumental and effective architectural exterior, provided with the most improved internal fittings and conveniences, its most striking feature has been the employment of artists of the first rank on the decorations of the public apartments on a scale not hitherto attempted in New York, with a sumptuousness of result and a disregard of expense almost bewildering. Of these the chief are the public dining-room on the Fifth avenue, with a ceiling decorated with three panels by Mr. Frederic Crowninshield; the "Marie Antoinette" room, a small parlor or reception-room, with a ceiling by Mr. Will H. Low; and the ball-room, to the ceiling of which Mr. Low again contributes three ceiling panels. The gentlemen's café and the conservatory, also on this floor, are noteworthy apartments, though neither is as elaborately decorated nor as successful as the larger rooms. It is a significant indication of the tendency of American hotel life that the large office or general assembly room, and the suites of public parlors, once invariable features of American hotels, are altogether wanting. As an offset to this the building is amply provided with suites of apartments, many of which have been decorated and furnished in distinctive styles, and form an unmatched series of private rooms. Notwithstanding the generally costly effect of these rooms, they have a rather unpleasant sensation of crowding, the sleeping-rooms being small and the greater space being given to the parlors. Doubtless from the hotel-keeper's standpoint this is just as it should be, but the impression is deeper from the apparent disregard of expense in the furniture and fittings. This is especially notable in the "state apartments"—a richly decorated and furnished suite set apart expressly for great personages only—though its drawing-room is of unusual size. The hotel is so large, also, that one rather looks for large rooms in its immense bulk, and this in itself may account for the impression made by the rooms. But it is to the public apartments on the ground floor to which the visitor's attention is most apt to be drawn, and in which he will find the greatest satisfaction. Opportunities for mural decoration on a large scale have been comparatively rare in this country, and the advantages offered in the Waldorf are the more striking because the work has been done by American artists. The success with which this has been accomplished marks a new era in American decoration which cannot but bear good and effective results in the near future. From this standpoint the Waldorf acquires an importance to which as a mere hotel it would not be entitled. It is easily one of the most notable public buildings in New York, and is a monument that reflects lasting credit upon all concerned in its production.

One of the most important measures now before the New York legislature is a uniform building law for the cities in the interior of the State, graded in proportion to their population, and embracing all cities save New York and Brooklyn. It has been prepared by a commission, of which Mr. William J. Fryer, the author of the New York city building-law, and without question the greatest living authority on the subject, is chairman. Apart from its local significance this law is noteworthy in marking a line of action that must, before long, be followed by all the States. Although drawn with the greatest care, and by a body of representative and capa-

ble men, the city of Buffalo has risen in opposition to it. And this, not because it finds the law faulty, but because its city charter, unlike the charter of other New York cities, expressly confers upon it the right to draft and ordain its own building-law. Unfortunately this privilege has not been properly availed of, for Buffalo is provided with a deficient and unsuitable law of home manufacture which it is now proposed to supplant by a more comprehensive State law. The question, from the Buffalo standpoint, is one wholly of local pride, yet the city now presents the extraordinary spectacle of seeking to refuse a good thing because it has something bad. In an interesting letter to the Buffalo *Courier* Mr. Fryer, in recounting some of the more glaring errors and omissions in the Buffalo local law, pithily points out the great importance of the building-law to every community. It is, indeed, as he says, of national importance, and is greater than the tariff question, the silver question, the temperance question, or any issue which divides political parties. Yet there are few subjects so little understood or appreciated. Our newspapers, magazines, and reviews are filled with political discussions, assumed to be of vital importance, yet the more pressing matters of life and death, of health and wealth, all of which are directly concerned in a wise and thorough building-law, are confined to a few technical journals, or only studied by a few specialists, like Mr. Fryer, who have devoted their lives to the thankless task of trying to get people to build safely and well. Nothing could exceed the horror felt and expressed when some great building catastrophe happens, entailing a great loss of life and money, and the public clamor for the swift punishment of all concerned is of the most active and commendable nature. But there are many grave defects in building, unguided by proper supervision and restriction, of which the public at large never hears, though human life is constantly jeopardized by it. It is to improve these conditions, and to help to save the present enormous and totally unnecessary losses from fire, that the proposed New York State law has been drafted. Movements such as these should have the support of all good citizens, irrespective of local pride or privileges. It is a subject that concerns not Buffalo alone, nor even New York State alone, but the country at large.

THERE has never been a more complete admission of the failure of competitions than is contained in the instructions to architects for the new city hall in New York. If there is any merit in architectural competitions, it must be that they afford the surest and best way for obtaining the best results. This being so, it is certainly a reasonable proposition that the man who gains the work is the very best individual to carry it out. His work has been examined and criticised and compared with the work of other men studying the same problem and looking for the same result. If the jurors are suited to their task, the successful competitor should, by the theory of competitions, be thoroughly well fitted for his work. There has never been a competition in America which will attract more attention than the New York city-hall competition; few programs have been prepared with greater care or by more distinguished authorities; yet these very same authorities have decreed it as one of the essentials that, if the author of the selected design be "an unsuitable person" for so important a work, the board of commissioners shall have the right to associate some other architect with him. Could anything be more significant of the real nature of competitions? Had these gentlemen said the competition was to be an exercise in drawing, and further added that the man who sent in the best-looking set of plans would get the building, they could not have more distinctly admitted the real nature of the whole matter. The point to be considered is not the wisdom of the provision, but simply its force as a commentary from the most exalted sources on the real value of competitions. If architecture is an art by which the young men and boys who throng the architects' offices can, by the mere exercise of their pencils, place themselves on a level with those who should be their masters, obviously our

whole architectural system needs to be reversed. But, after all, it may be questioned if this provision is needed. Great municipal buildings are not designed by undergraduates in our colleges and offices, nor is the technical skill necessary to produce a passable set of drawings to be obtained without many years of arduous study and long experience in handling difficult problems. The competition will undoubtedly afford a great opportunity for many young men, and many of them will avail themselves of it, but their enthusiasm may well be dampened by the fear lest the board of commissioners, in the exercise of the wisdom requisite for the fulfilling of their task, designates them by the horrid word "unsuitable."

SOME large fires in so-called fire-proof buildings during the past month have attracted unusual attention, not only from their own importance, but because they have presented almost the first serious test of modern methods of construction. The most notable instances were the Boston fire (March 11) and the fire in the Temple Court annex in New York city. In the two cases the conditions differed, though both fires originated in what are called fire-proof structures. In Boston the fire started in a store filled with an immense stock of inflammable material. A terrific heat was very soon generated, and it was absolutely impossible for any form of construction to resist it. In New York the fire was confined to an office-building, and was fed by the furniture and interior woodwork. This, as has so frequently been the case, had not been reduced to the smallest minimum. This is not the first time this lesson has been taught, nor is it likely to be the last. Yet with an example such as this builders and owners must recognize the folly of erecting costly edifices in a manner which will enable them to burn down at the first opportunity. Until some enterprising genius puts his mind down to devising a substitute for wood, human affairs must be conducted with more or less of this material. Experience has shown that safety lies only in using it in the smallest possible quantity. A modern office-building is so complex a structure, the electrical devices necessarily employed in it are so constant a source of danger, and accumulations of inflammable material in it so difficult to avoid, that it should not be imperiled by the incorporation of wood in its construction. The Temple Court fire teaches a further lesson in showing the danger that exists in very large windows ranged closely together, and with scarcely more than the space between floor and ceiling between different floors. There is little doubt, apparently, that the fire was communicated from one floor to another in this manner, the wooden-window frames forming an effective means of transferance. As it is further supposed that the fire may have been in progress several hours before being discovered, it is obvious that by a rigid and careful inspection a very large amount of the damage done might have been prevented.

M. CORROYER'S book on Gothic architecture* may be safely recommended to all students of architecture. It is very French, as may be expected from any French writer writing on Gothic architecture, and it would have been better, perhaps, if the author had confined himself wholly to French art instead of using a few illustrations of foreign Gothic, which only help to make his general treatment insignificant instead of adding to it. It is burdened likewise with a most impossible theory on the origin of Gothic architecture, which M. Corroyer thinks is derived from the cupola, typified in the cupolas of the cathedral of St. Front at Périgueux. Hardly anything could be more improbable, and it is unfortunate that the editor did not enter a protest against it. As a summary of French Gothic architecture the book is very good. The examples illustrated are numerous, and include not only general views and parts of buildings, but plans and sections, the later being, in many cases, new to readers whose knowledge of Gothic architecture has been derived from English text-books. The illustrations are well printed.

*_Gothic Architecture._ By Edouard Corroyer. Edited by Walter Armstrong. New York: Macmillan.

INDUSTRIAL CHEMISTRY.

Conducted by Dr. R. A. Witthaus.

THE recent experiments of M. Henri Moissan with high temperatures are most interesting and his results well-nigh incredible. M. Moissan, however, needs no introduction, his work with the element Fluorin being well known and a sufficient guarantee of his exactness. It has been determined quite recently that, owing to imperfections in the pyrometers formerly used, the temperatures above 1000° C. have been grossly exaggerated. The highest temperature attainable by coal-gas and an oxygen blast is about 2000° C., while the highest temperature utilized in industrial work is only about 1500° C. At the former temperature a quicklime crucible only can be used. Hence it will be seen that the temperatures obtained by M. Moissan are most remarkable. For these higher temperatures a furnace is constructed of two bricks of quicklime, carefully cut out and placed one above the other, the lower brick having two longitudinal grooves for the electrodes and a small cavity in the middle to serve as a crucible. The arrangement is thus similar to that used in melting platinum. In the first experiments a small Edison dynamo driven by a gas-engine was used. A current of 30 amperes and 55 volts gave a temperature not much exceeding 2250° C. Later a current of 450 amperes at 70 volts was used, representing about 50 horse-power, and with this 3000° C. was attained.

At 2500° C. the oxids of calcium, strontium, and magnesium crystallized rapidly, and at 3000° C. the quicklime of which the furnace was composed ran like water. At this same temperature the lime was reduced by carbon, and the metal calcium was "liberated in abundance." A carbid of calcium was also obtained fusible at a red heat. Fine crystals of the borids and silicids were readily formed. Magnesia was melted as easily as the lime, and alumina was melted and crystallized at 2250° C. By the addition of a small amount of the oxid of chromium, artificial rubies were obtained. By continuing the treatment of alumina this was completely volatilized, thus providing a parallel case to the volatilization of silica, effected by Seger. Titanic acid was crystallized, fused, and volatilized according to the temperature, and zinc oxid was volatilized freely and deposited in long, transparent needles. M. Moissan, it is said, has also produced a number of microscopic diamonds by the crystallization of carbon after the following method: Pure carbon obtained by burning sugar was dissolved in an ingot of iron and this then heated to 3000° C. By the application of cold water a sudden crystallization was effected, and true diamonds of microscopic size were obtained. As M. Moissan is continuing his researches, further results will be looked for with interest.

TURNING from one extreme of temperature to the other, we have the investigations of Pictet in chemical action at temperatures ranging from −50° C. to −155° C. Under the influence of this extreme cold chemical action apparently ceases. For instance, 89 per cent. sulfuric acid, which freezes at −56° C., if cooled to −125° C., may be powdered and mixed with caustic soda of the same temperature without chemical effect. When this mixture is subjected to the spark from a Ruhmkorff coil, reaction slowly sets in and at −80° C. pervades the mass. With ammonia, sulfuric acid reacted at −80° C. to a limited degree, but at −60° the reaction was complete and there was a sudden rise in temperature. With sodium chlorid the acid gave no reaction at −50°

C., at 25° C. there was limited reaction, and above this the reaction was complete. The following are the author's conclusions:

1. At temperatures between −155° C. and −125° C. no chemical action is perceptible, whatever the nature of the substances employed.

2. Delicate tests, such as those with acids upon litmus paper, can be successfully applied at lower temperatures than may consist with very energetic reactions of other kinds, *e. g.*, that between sodium and sulfuric acid.

3. Every chemical action, according to the temperature at which it takes place, appears under one of two forms: (a) Slow action, which follows when the temperature is kept beneath a certain limit, varying with the substances employed, this kind of action being brought about either by an electric spark or spontaneously, depending upon the difference between the actual temperature and the above limit; (b) complete action, in which the heat generated by chemical union is communicated to the neighboring parts of the compound, until these are equally involved. In order to maintain slow action it is necessary in most cases that this heat be carried off by radiation; otherwise the temperature will very soon rise to that of complete action.

4. The best excitant of slow action is apparently the electric spark.

5. It is experimentally established that every chemical action commences with a period of negative energy, *i. e.*, a period in which external activity must be furnished to the component bodies, in order to allow of their combining.

AN interesting paper on the "vulcanizing process" for wood was read by Mr. H. C. Myers, before the National Electric Light Association at the St. Louis meeting in February. Pointing out that the annual consumption of wood in this country equals twice the amount of material supplied by the annual growth of our forests, Mr. Myers shows the necessity of wood preservation and wood strengthening. He then speaks of the composition of wood as it exists in nature: "Cellulose impregnated with resin, volatile oils, sugar, gum, tannin, protein bodies, and the usual mineral constituents of plants." In the distillation of wood the cellulose decomposes and a chemical change takes place between it and the natural constituents of the sap, resulting in a powerful antiseptic mixture containing acetic acid, methyl alcohol, acetone, methyl acetate, tarry matter containing phenol, creosote, carbolic acid, and about thirty other substances of lesser importance. Mr. Myers divides the processes now used for the preservation of wood into two classes: (1) those in which wood is impregnated with a preservative material by immersion, and (2) those in which a preservative agent is forced into the pores of the wood. Copper sulfate, zinc chlorid, mercuric chlorid, dead oil, etc., are among the chemicals used. In the new "vulcanizing" process the timber is heated to a temperature at which the chemical changes, spoken of above, take place, but instead of distillation from the wood the antiseptic products are retained under pressure. The process is described as follows: The "wood is heated in closed cylinders from eight to twelve hours at a temperature ranging from 300° to 500° Fahrenheit and under a pressure of from 150 to 200 pounds to the square inch. A circulation of superheated and dried compressed air removes the surface moisture and any water that does not enter into the reaction and combine with the woody constituents. Hence wood or timber in any condition may be immediately treated. These cylinders for the treatment are 105 feet long, 6½ feet in diameter, and are made of steel. As the treatment penetrates to the heart of the timber, considerable time is required for cooling, which is, of course, done in the cylinder and under pressure. Timber is introduced and treated upon cars which run into the cylinder on small tracks." The percentage of dark antiseptic matter in the vulcanized product varies with the different woods, and in the samples examined by Mr. Myers ran from a minimum of 54 per cent. to a maximum of 59 per cent. This process apparently makes decay impossible

by sealing up the pores of the wood with antiseptic matter and, moreover, by tests made at the School of Mines in New York city, the average increase in strength after treatment amounts to 18.9 per cent. Confirmative tests with like results were made by Professor R. H. Thurston, and Professor Alfred Trautwein, of Stevens' Institute, Hoboken, and also by a committee of naval experts. "The process of vulcanizing seasons all timber, thoroughly preventing any further warping, checking, or cracking. Such timber is not influenced by atmospheric agencies, bacteria, or spores, and requires no paint for protection, as it is saturated with antiseptic preserving material of its own; the albuminous constituents of the natural wood have been coagulated by the high heating and rendered insoluble." A further valuable effect of the vulcanizing is in the rendering of soft and non-durable woods hard and permanent. The loblolly pine of the South decays rapidly when untreated, but after treatment is as durable as ordinary timber and ties used in railway construction. "As vulcanizing changes the sap from the liquid to the solid or semi-solid state, does not char or make the wood brittle, saturates and seals up the pores of timber with solid matter instead of liquid soluble matter which nature provides, considerable strength and durability are added by vulcanizing, the wood being rendered more cohesive, harder, and denser. The spike-holding quality is naturally much increased, and even after ten years' service railroad spikes seem to be as firmly imbedded as when just driven. It is also a curious fact that the electrical resistance of most woods is very greatly increased by vulcanizing."

PROFESSOR W. M. HARTLEY, F. R. S., has recently described a new process for the preparation of drying oils, consisting in first refining the oil, by removing therefrom the water and mucilage contained; second, boiling and bleaching the oil in one operation. For the removal of the water and mucilage, various processes are in use, as for instance by alum, by sulfuric acid, or by zinc chlorid, but all of these offer serious objections. With the zinc chlorid the expense is too great, while with strong sulfuric acid the oil, or some of its impurities, becomes charred, and a brown color is the result. Professor Hartley advises the use of pure neutral manganese sulfate, but for ordinary purposes dilute sulfuric, 30 per cent., answers well, withdrawing the water and precipitating the mucilage without charring. The oil thus produced is bright, clear, and slightly yellowish in color. Having been purified, the oil is ready for the next step, the bleaching and oxidizing treatment. Binks has long used the oxids of manganese in bleaching and boiling, but with indifferent success owing to the difficulty experienced in regulating the quantity of the manganese compounds to be added.

Professor Hartley prepares manganese linoleate, dissolves this in a hydrocarbon, and adds the solution to the oil. The coloring matters combining with the manganese compound are oxidized and destroyed, the manganese being deoxidized. Subsequent oxidation in the oil produces acrolein, formic, and acetic acids. The resulting oil is light in color and of excellent quality. In order that its superiority may be the more clear, the following defects in ordinary drying oils are pointed out: (1) Zinc white mixed with ordinary boiled oil darkens; (2) patent non-poisonous white lead is also darkened; (3) lead sulfate with ordinary boiled oil darkens; and (4) all delicate colors are darkened if mixed with ordinary boiled oil. The advantages of an oil made as described by Professor Hartley would be that zinc white, white lead, and all delicate colors when mixed therewith would retain their proper brilliancy and shade even after a considerable exposure.

FOR the purpose of comparing the river pollution of one time with that of another, Herr R. Baumeister proposes the use of a formula designed to represent approximately a coefficient of pollution. Chemical analysis fails in making these comparisons, owing to the wide differences in local conditions. Von Pettenkofer has laid down the rule that no harm can arise when the volume of sewer-water is not

more than one-fifteenth that of the river into which it passes. Baumeister, however, shows the uncertainty of such a law, depending as it does on the variable factor of water supply per capita, and proposes more wisely to set down the population contributing to the sewers as the figure to be taken into account when calculating the pollution. Considering the suspended organic matter, and all matter, organic and inorganic, in solution, as pollution, he assumes 190 grams per capit. per diem as representing the average amount of impurities discharged from water-carriage towns. As in many towns the dejections of only a certain proportion of the population reach the river, this proportion in the formula is represented by C and all other impurities by I, $I+C$ then representing the total amount of impurities conveyed to the river. According to von Pettenkofer, the velocity of the stream should at least be equal to the velocity of flow in the sewer, or not less than 0.6 meters per second. The coefficient of pollution then is represented by the formula: $\frac{Qv}{E(I+C.)}$, in which Q equals the daily flow in cubic meters when the river is at its lowest level, or 86,400 q, q being the volume in cubic meters per second. V equals the mean velocity in meters per second. E equals the population, and C the proportion of the inhabitants who regularly contribute to the sewers as above stated. A table of coefficients for a few of the principal towns in Europe is given by Baumeister, but the formula is rather a suggestion, and exactness is not claimed, the author himself indicating some of its weak points.

THE following notes on smoke-prevention are abstracted from a report of the special committee of the St. Louis Engineering Club. The various apparatus and processes for smoke-prevention have in many instances proved to be unsuccessful mainly because of lack of care and attention, and also because of entire ignorance of the principles involved in combustion. By the application of heat the organic matter in the coal is decomposed, and "gaseous carbon" and hydrogen are given off, but the heat may not be sufficient to effect a chemical union between these gases and the oxygen of the air, in which case heat is absorbed. When the hydrocarbon vapors are decomposed, carbonic acid, CO_2, and water, H_2O, may result from the complete combustion of some part of them, while another portion has some of its carbon separated, leaving a light hydro-carbon gas, $C_2H_4=C+CH_4$. It is this separated carbon in an incandescent state which gives luminosity to the flame, and which forms the visible smoke during the burning of bituminous coal. For the combustion of this separated carbon a strong oxidizing influence is necessary and also a high temperature. If the high temperature be wanting, the carbon is carried along by the draught and passes off as smoke. The most important of the many types of smoke preventers are included under the following heads: (1) steam-jets; (2) fire-brick arches, or checker work; (3) hollow walls for preheating the air; (4) cooking arches or chambers; (5) double combustion; (6) downward-draught furnaces; and (7) automatic stokers.

The steam-jet is used to force air into the fire-place either directly or after being heated, in quantity sufficient for the complete combustion of the gases. This requires care and regulation by an experienced hand. If the nozzles are not well-adjusted, a blow-pipe action is obtained upon the boiler or upon the grate-bars, and one or the other is thereby rapidly burned.

The fire-brick arches and checker work subdivide the current of gases, and maintain a uniform and higher temperature throughout. They are useful in this way, but the cost of maintenance is somewhat high. The systems based upon hollow walls and those upon the use of coking chambers were considered by the committee as objectionable. In the downward draught furnaces the fire-place back is closed, and the smoke and gases can escape only by passing downward through the fire-bed itself. Owing to the high heat thus developed on the bed, water-tubes are used in place of the ordinary bars. This

system is regarded favorably, as likely to be perfected and to be made of great value. Automatic stokers supplying a regular and uniform feeding to the fire-place by mechanical means were regarded as too limited in their applicability.

It is curious that where the combustion is presumably the most complete,—that is, without the production of smoke,—there is a loss in the heating power of the fuel, an increase in coal consumption, and a loss in economy.

IN the February *Dixie* (Atlanta, Ga.) Dr. Robert Grimshaw gives a short account of the Hercules ironworks plant for the manfacture of ice at the World's Fair. This plant will be most interesting and will attract many visitors, for, though artificial ice is as common an article in our households as is the natural product, still there are many persons—and not all of them ladies—who have not the faintest idea of how it is made. The plant at the World's Fair will supply the demands of 175,000 daily visitors, and hence the 150x300 feet space allotted to it will not be any more than is necessary. The building itself will cover a space of 130x255 feet, will be five stories high, and decidedly unique and artistic in its simple decoration. The engine-room, the first from the main entrance, will contain three 120-ton "Hercules" machines of the latest pattern. On either side will be located the dynamos for both arc and incandescent systems, air-pumps, and motive machinery for the passenger and freight elevators. The engine-room itself is 80 feet square, light and airy, occupying two of the five stories. At one end is a raised platform for visitors. The boiler equipment will be of 800 horse-power and representing the two types of tubular and water tube boilers, which will be carefully compared. "Above the boiler-room is a fire-proof story in which will be located the ammonia condensers and water purifying apparatus. To the left of the boiler house and engine-room, and entered from the latter, will be located the ice storage house and the ice tanks for the manufacture of ice by both the plate and can systems. This department will be 100x130 feet in size, two stories high. To the ice manufacturer it will have the highest interest, since under one roof and side by side will be seen in operation the manufacture of ice under all conditions and by all the processes which have by experience been declared or deemed successful: (1) By the plate system, from filtered water; (2) by the can system from condensed steam thoroughly filtered and purified; and (3) by the can system from de-aerated water, thus giving all processes full representation. The tanks have nominal capacity for eighty tons of ice daily, but will be capable of producing ninety to ninety-five tons when required. By the plate system ten tons daily will be produced." Pneumatic hoists and electric cranes will be used in handling the ice. Storage capacity for 3000 tons of ice is provided, and also a cold storage for meats, vegetables, fruits, etc.

SPEAKING of powdered coal, Mr. R. H. Humphreys has recently made some experiments upon its use in gas-works which show that the old objections to its use are well founded. The experiments were carried on in a bed of three 15-inch round retorts working under regular conditions and using the same class of coal, screened and ground. With the ground coal a superior coke is produced and also an increase in the yield of the same, but the gas was deficient, as will be seen from the following: The consumption of fuel and of labor being the same, the screened coal could be worked off in six hours, or at the rate of four charges per day, yielding 15,600 cubic feet of gas; whereas the ground coal could only be worked at the rate of three charges per day, yielding 9010 cubic feet of gas. There was no improvement in quality with the smaller yield. The fine coal produced clouds of dust in charging and caused much discomfort to the workmen, no flame issued, and the temperature was lowered.

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

INCREASED use of various wet processes of treating ores has directed attention to the question of the best material for and construction of the tanks required. In handling small quantities wooden or light iron tanks answer the purpose; but when treating large quantities—the only way in which some processes can be advantageously applied—it is not so advisable to increase the plant by using greater numbers of the tanks as to increase the individual capacity of each tank. Economical handling calls for the least possible number of separate operations, and the work of charging or emptying is not so very different, whether the vat is a large or a small one. Formerly a maximum limit was supposed to be about 100 tons, but 360-ton wooden tanks have lately been built in the Transvaal, and there is no reason to believe that it would be impossible to construct iron or steel tanks of large size. A great difficulty with wooden tanks has been to prevent shrinkage and leakage. Various preparations of tar, asphaltum, etc., have been tried, metallic paints being inadmissible on account of chemical action. Paraffine also has been employed to prevent absorption and leakage.

In the use of some solutions the organic matter (the wood of the tanks) is found to have a reducing effect upon the solution, lowering its strength. For any process requiring especial minuteness in manipulation and which would admit of care at the expense of time, iron tanks of moderate size coopered with strong iron or steel bands, tautened with turnbuckles, are preferable; but it is doubtful whether any process can be worked to the best advantage on the small scale. For a permanent plant of large capacity the best construction is probably brick and cement, or cement built into excavations in natural rock. On this system the only limit to the size is that determined by convenience and the requirements of the process.

A LARGE proportion of the expense in any wet process is due to the labor of emptying the tanks of the spent material. Shoveling it out by hand is a slow and tiresome matter, and the various mechanical devices (cranes, scoops, etc.) that have been tried are not much better. The writer once devised a form of settling tanks for wet-crushing silver mills which was self-discharging, at the bottom.* Since then settling tanks discharging at the bottom have been built in a few amalgamating mills, as at the DeLamar, Idaho. Evidently all leaching- and settling-tanks ought to be self-discharging or as nearly so as possible,—that is, through the bottom, or in the case of very small receptacles possibly by rotation and dumping. Cement-tanks can be discharged through openings in the floors communicating with tunnels, an arrangement already adopted.

On the same principle the filling of the tanks should be as nearly automatic as possible,—that is, by inclined chutes, hoppers, or dumping-cars run on tracks over the tanks. The economical working of any lixiviation process, whether hypo., cyanide, or whatever it may be, and of all wet processes in general, will depend very largely on the arrangement of the apparatus and appliances for continuous downgrade movement of all solid material, avoiding all needless handling and confining the lifting work to the pumping back of water and solution. The problem is the same that has been so successfully solved in the case of the great gold stamp mills of California, South Dakota, and Alaska, whose remarkable records have been permissible only by suppressing all unnecessary labor. If a 120-stamp mill can be run

* Transactions American Institute of Mining Engineers, 1883.

by six men per shift, why not a leaching plant of equivalent capacity?

THE California State mining bureau had a narrow escape from being abolished by the legislative session lately closed; but it has been remodeled by a new act which supplants all former organic laws, and after passing through the critical stage in its history it begins a new tenure of life, with a new chief and a brand-new appropriation of $50,000. It is to be hoped that under the present regime it may be of some real utility to the miners. Thus far an immense amount of money has been expended upon it, besides which it has been liberally aided by private donations to its collections and by volunteer assistance, but without commensurate results, unless the voluminous and rambling reports published be considered as such. California earnestly desires an efficient mining bureau, and has tried hard enough to get one.

In Colorado a bill to establish a similar State mining bureau has been killed in the legislature. Perhaps it is just as well. The purpose of such organizations is wholly commendable, and one can imagine a mining bureau which would be a source of authentic information, a great help in developing the resources of the State, and a trustworthy guide to investors. Unfortunately, if past experience with corresponding organizations is any test, the sanguine hopes of the promoters would be unlikely to be realized had the bureau been created. Before an efficient bureau could be established certain prerequisites are in point. It would be necessary to make sure of a decided change in the tone of local politics and to have available a personnel that would command the respect of public opinion, have some interest in its work other than that of drawing salaries, and be technically competent. It is generally found that in such cases the men in charge are either beguiled by "high science" on the one hand or are contented with practical politics on the other. Colorado has already a labor commission and a World's Fair commission, and has learned that the chances of useful results in this line of work—results worth the expenditure—are not enticing.

AMONG the great silver mines of the day, the world over, that of the Broken Hill Proprietary Co., New South Wales, unquestionably takes the lead. Its record is still below that of the bonanza mines of the Comstock, but it has already paid dividends amounting to $18,363,120, cash bonuses of $2,883,040, and stock dividends of a nominal value of about $8,500,000. For the first time in its history the last semi-annual report shows a falling off from that of the preceding half year, this being explained by the long stoppage during the fall of 1892 on account of a labor strike; but it yielded 2,310,208 ounces of silver and 9650 tons of lead, from 73,973 tons of ore, during the six months. The average cost of mining was $8.024 per ton; of smelting, $8.18 per ton; and total average expenses, $18.73. The gross yield being $27.37, the net profits were $8.64 per ton. Apart from its productiveness, the mine is remarkable for the problems presented in its technical management, much difficulty having been experienced in avoiding creeps and cavings with ground so extensively stoped, while the proper treatment of its complex ores has been a puzzling and disputed question. Its reduction works include plant for concentrating, smelting, leaching, amalgamating, and refining, and there has been no lack of experimentation in various directions. The most serious metallurgical mistake which seems to have been made was one that has often occurred in other districts where true smelting ores have been the main reliance, and that is the selection of the richest and most easily reducible ores for smelting at first, thus leaving the more refractory to make trouble later, instead of attacking the whole metallurgical question in its entirety at the outset, and regarding the true smelting ores as the basis and economizing their fluxing qualities to offset the objectionable elements of the dry and refractory ores. An agent of the mine visited the more important reduction works of the United States last year in order to study the best American practice

in treating similar ores. The smelting cost at Broken Hill ($8.18) is not very high, however, and will probably be reduced somewhat by the addition to and improvements in the company's plant.

THE greatest silver-producing mine in South America at present is the Huanchaca, situated in a group of hills on the central table-land of Bolivia, at an altitude of 13,400 feet. A railroad 395 miles long connects it with Autofagasta, a Chilian port. Since 1876 the gross production has been about $46,000,000, of which about $15,000,000 has been paid as dividends. The expenses have been very high,—$28 per ton for mining, hauling, and sorting, and $24 for milling. A large amount of low-grade ore (that is, low-grade for the locality) has accumulated; and now that the railroad has been completed it is the intention to discard the expensive mill near the mine and treat the low and medium ores at large works on the coast, shipping the highest-grade ore.

CHROME iron-ore mining in California, according to the *Mining and Scientific Press*, is in an unsatisfactory condition owing to various causes,—the great distance from the centers where the ore is utilized and the cost of freight to these markets (Baltimore and Philadelphia mainly), the desultory manner in which mining is carried on, and the need of good wagon roads and near-by railroads. There are many known deposits, but they are mostly in pockets; and of the larger ones at a distance from transportation facilities the richer ores have been taken out and shipped, leaving the poorer ores until the conditions will admit of their being profitably mined and shipped. There is no apparent chance of establishing a chrome steel industry in California, but it would appear that there is an opening for local manufacture of chemical products from chrome ores, which ought to pay better than shipping the crude material.

LOWER expense records than that of the Alaska-Treadwell gold mine, Alaska, have been made; but considering the conditions its showing for the last year is a notable one. There were 120,000 tons of ore mined and treated, at a total average cost of $1.82 per ton, divided as follows: Mining, 65 cents; milling and concentration, 33 cents; chlorination, 19 cents on the total tonnage, $8.42 per ton of concentrates; general mine expenses, office expenses, bullion freight, insurance, etc., 15 cents per ton. People who have schemes for improvements in gold metallurgy would do well to consider these figures.

ABOUT 15 per cent. of the gold output of the Rand mines, South Africa, during the last half of 1892 was obtained by the cyanide process. Twenty-four of the companies operating there are either treating or are preparing to treat their tailings by this method, and it is estimated that some 150,000 tons of tailings will have to be treated monthly by this process. Mr. W. G. Shaw, in the Johannesburg *Star*, says that the day may be looked forward to when 3-dwt. tailings will thus be profitably handled. He gives some very favorable figures for the working results, and says: "After a careful course of inquiries, I consider the average cost of treatment by cyanide to be $1.65 per ton, with an extraction of 67 per cent. of the gold." This is by no means as high as the promoters of the cyanide process claim, but it is very much better than its detractors allege.

RECENT discussion of the genesis of metalliferous-ore veins has elicited interesting expressions of opinion from mining engineers, but it is to be remarked that such men prefer to appeal to observed facts rather than to *à priori* theory. In the debate betwen the adherents of the lateral-secretion theory of Sandberger on the one side, and of the deep-seated source theory of the older geologists on the other, it is well to remember that there is no necessary antagonism between the two ideas, unless either or both are pushed to a degree of exactness which is unwarrantable by actual occurrences viewed as a whole. The more advanced supporters of the lateral-secretion theory apply it as a very flexible hypothe-

sis, only claiming that the ore is derived from mineral preëxisting in the country rocks somewhere in the neighborhood of the deposit, from above, from the side, or even from somewhat below, but in the course of percolating waters from the surface, which may reascend under hydrostatic head as well as descend or flow laterally. There is no reason why we should be limited to any one particular explanation of the mode of vein filling. Some veins may be formed in one way, some in another. Nature is not niggardly in expedients.

ALUMINUM has some new applications. One is in the manufacture of the sound-cases or bodies of violins and other stringed instruments, for which its resonant quality fits it. Another is as durable "slate pencils," the metal having been found to mark well on slate of proper grain. It has been successfully tested as a material for horseshoes in the Russian cavalry service, and may come into common use for the shoes of racehorses. There has been some talk of adopting it in the German army for the metallic parts of military accoutrements, in order to reduce the weight carried by the soldiers, and even for cartridge shells in place of brass or copper.

IN a paper on underground haulage by electric locomotives in coal mines, by M. Clément Baily, a Hainault engineer, the drawbacks of chain haulage (which would apply in part to wire-rope haulage) are summed up as follows: Higher first cost; encumbrance of the main roadways, so that an accident may interrupt the output; and the necessity generally of a double line of way, forming an obstacle to the passage of the men. These objections, in conjunction with the rapid progress of electric haulage during the last few years, are influencing the preference of foreign engineers for the electric system wherever applicable, as is shown not only by the actual adoption of that system to a large extent in French, Belgian, and German mines, but by the tone of the papers read at the meetings of European engineering societies and the discussions in the technical press. In this direction it appears that American practice is hardly abreast with the most advanced practice on the continent of Europe. This may be due to the well-grounded apprehension that the use of any electric motor that is liable to sparking in a gaseous colliery would introduce a new element of danger. M. Baily, arguing in favor of electric haulage, makes these points in contrast to those just cited: That the installation is very simple; that the gangway may be kept single; and that in case of a breakdown the electric locomotive may be at once superseded by horses or mules. He also adds that the electric locomotive, besides being more economical than horse traction, conveys the men to the working places rapidly and extends the radius at which coal may be mined from the shaft.

SOMETIMES it happens that a reported or proposed metallurgical process seems "in the nature of things" to be a chemical impossibility. Whenever we are confronted with a case of this kind, it is well to recall some past surprises and be cautious about forming negative judgments from preconceived limitations. Many such warnings have been given, but forgotten. A good instance in point was the upsetting of dogmatic opinion brought about a few years ago by Professor Dudley's neat little trick in fusing and molding iridium. This metal was considered hopelessly refractory, —a feature much deplored in view of its useful qualities for certain purposes. To make an easily fusible phosphid, manipulate it into shape, and then expel the phosphorus seems simple enough now that we know how it is done—like the mythical egg of Columbus, to use a trite simile. There are plenty of problems that are now puzzling metallurgists which doubtless admit of unexpectedly easy solution, and which are destined to be solved some time or another, very likely by accidental discovery. Then it will be wondered why somebody in 1893 hadn't the sense to see how.

ONE reason for the recent labor troubles in the precious-metal mines of the West, it must be confessed, has been a certain lowering in the general average tone of

the men, a point in singular contrast to the immense improvement in the technical methods of mining during the last few years. This is deplorable, and the statement may arouse opposition, but there is no use in concealing the undeniable truth. It used to be a matter of common observation that the farther one went from the railroads and beaten tracks, the more intelligent the men one would meet. They were the pioneers, the prospectors, and naturally more enterprising than the ordinary mine laborers. Such men were not strikers, and when they joined the miners' union they retained their common sense. In large part they were Americans, not satisfied with being mere wage-workers for life, but working at times for wages in order to become free to prosecute prospecting or mining on their own account, and hence more in sympathy with temporary employers. Now the railroad goes almost everywhere, and a cheaper, less enterprising class are coming in. So far there is no great influx of Huns, Poles, and Italians, but there is a decided approach to the tone of the eastern coal mines, and it is only a question of time when the average for the whole country will be equalized and the "labor problem" become a more serious one. It may be wondered whether the labor problem in Australia, so vividly depicted by Mr. Edmund Mitchell in the April number of this magazine, was not due in part to a deterioration of tone caused by the later immigration.

BLOCK TIN is again on the free list, the bill to prevent the taking effect of the McKinley tariff act in the case of tin having been passed by Congress at the close of the last session. Thus far neither the Broad Arrow, the Rockbridge or King's Mountain, the Temescal or the numerous properties of the Harney Peak Co. have come up to the flattering predictions and anticipations. One of the strangest facts in the mineral history of the United States has been the failure to achieve better results in this direction in view of the great number of known occurrences of tin ore, their wide geographical distribution, and the persistent and costly attempts made to develop profitable tin mines. Of course there are still chances for the establishment of a real tin-mining industry, and it would be foolish to venture on negative prophecies. The country needs tin and will have to continue importing it for the present, if a tin-plate industry is to be built up, unless something unexpected happens to the tin mines or new deposits are found. At the same time it is well to remember that the making of tin-plate is rather a branch of the iron and steel trade than anything else. The proportionate amount and value of the pure tin to the whole cost is not very large, manufacturers having learned to get along with about 3 per cent. and for cheaper grades only about 2 per cent. of tin in the total weight, the main expense being for the rolling and manipulation of the sheet iron and sheet steel used for the body of the plates.

FAVORABLE reports come from Idaho's opal field. The town of Opaline has stage roads running to it. Mining is being systematically, and it is said profitably, pursued in spite of the scarcity of water, to remedy which it is proposed to sink artesian wells.

FIVE folios of the geological atlas of the United States, and proof copies, have been kindly furnished this department by Colonel H. C. Rizer, chief clerk of the United States Geological Survey, who writes that as the folios have passed the experimental stage it is hoped that their publication in large editions will be begun in a short time.

THE anthracite coal monument for the Columbian Exposition has been prepared by the Lehigh Valley Coal Co. It is about fifty feet high, ten feet square at the base, and three or four feet square at the top. *Black Diamond* reports that experts who have examined the plans and work say that the exhibit will be one of the finest ever made in the interest of the anthracite trade.

THE TECHNICAL INDEX.

A CATALOGUE OF LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

THIS publication has been aptly described as "the greatest step that has been taken in recent years towards systematizing work" for the engineer, the architect, the electrician, the railway manager, and the business man. The list of publications regularly indexed will show that it covers a world-wide range of the best technical literature, and all the articles are so conveniently classified under general headings that within a few minutes an active man can learn of everything that has been published during the month in relation to his special lines of investigation. In short, it is to the practical man just what Poole's celebrated index to periodicals has long been to the literary worker, but with this essential difference,—namely, that in addition to indicating *just where* leading articles have been published, *we undertake to supply copies of the articles themselves.* The unparalleled convenience and economy of this double service can readily be appreciated.

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[In the body of the index only the initials of the journals quoted are given, and these can be readily identified by the following list of periodicals. Other abbreviations are: Ill=Illustrated. w=words.]

THE AMERICAN PRESS.

A .....Arena. *m.* $5 per year. Boston.
AA.....American Architect. *w.* $6. Boston.
An A A..Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An....American Analyst. *f.* $1 per year. N. Y.
A Ar.....American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B M...Architect, Builder, and Manufacturer. *m.* $1.50. Kansas City, Mo.
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11779. The Grave of Benjamin Franklin. Ill. (E W–April 8.) 500 w.

11796. Weston Electrical Measuring Instruments. Ill. (E R N Y–April 8.) 2500 w.

11800. The Most Economical Boiler and Engine for Central Stations. J. A. Farlinger (C E N–April.) 4500 w.

11833. Electric Bolt Operating Mechanism for Safes. Ill. (W E–April 8.) 900 w.

11834. Electrical Development Abroad (W E–April 8.) 1700 w.

11837. Experience with Electrical Subways n New York (E N–April 6.) 3000 w.

11840. Putting Electric Wires Under Ground. Editorial (E N–April 6.) 1700 w.

Serials.

8905. Sparking at Commutators. Ill. F. M. Weymouth (El–Began Dec. 7—Ended March 17—8 parts—30 cts. each).

9713. Alternating Current Apparatus. C. Kammeyer (W F E E–Began Jan—Ended March —3 parts—30 cts. each).

10170. Electrical Oscillations of High Frequency. Ervin S. Ferry (E W–Began Feb. 4 —Ended March 18—4 parts—15 cts. each).

10600. Electrical Measurements. Ill. George D. Shepardson (S R R–Began Feb.—2 parts to date—30 cts. each).

10659. Influence of Frequency in the Working of Alternate Current Transformers. Ill. Charles Steinmetz (E E N Y–Began Feb. 22—3 parts to date—15 cts. each).

10843. Conductors and Insulators. Ill. Reginald A. Fessenden (E W–Began March 4—3 parts to date—15 cts. each).

10995. On Testing and Working Alternators. Ill. W. M. Mordey (E E L–Began Feb. 24—Ended March 3—2 parts—30 cts. each).

11046. Some Experiences with the Alternating System. R. H. Sterling (E A–Began March 4—2 parts to date—15 cts. each).

11129. Some Principles That Must Be Observed in Order to Make a Good Closed Circuit Battery, and a New Portable Dry Cell Described in which These Principles Are Applied. E. F. Northrup (J F I–Began March—2 parts to date—45 cts. each).

11501. Theory of the Transformer. Ill. F. Bedell and A. C. Crehore (E W–Began March 25—2 parts to date—15 cts. each).

11560. Electricity as a Motive Power. Albion T. Snell (El–Began March 17—1 part to date—30 cts).

ELECTRIC LIGHTING.

11109. The Incandescent Lamp. Jas. A. Lightipe (P L–March 2.) 2400 w.

*11225. Electric Lighting Schemes for Strassburg (E E L–March 3) 1600 w.

†11302. Comparison of Cost of Electric Lighting of Columbia College by Separate Plant and by Contract with Companies. W. W. Reese and Archibald Anthon (S M Q–Jan.) 1000 w.

11324. Electric Installations and Some Radical Changes in General Systems of Wiring. Ill. Charles G. Armstrong (W E–March 18.) 3500 w.

11325. Development of the Incandescent Lamp. Edward Weston (W E–March 18.) 6000 w.

*11404. Lighting by Phosphorescent Tubes. Ill. (E E L–March 10.) 2000 w.

11445. The von der Kammer Incandescent Lamp. Ill. (E E N Y-March 22.) 300 w.

11448. Search Light Projectors—An Experimental Comparison of the Mangin and Schuckert Projectors. M. Burstyn (E E N Y-March 22.) 2500 w.

11449. The "Incandescent Arc" Lamp as a Rival to the Incandescent Lamp. A. Noll (E E N Y-March 22.) 1600 w.

11450. A Compact Plant. The Electrical Equipment of the Havemeyer Building. Ill. (E N Y-March 22.) 800 w.

11451. The Incandescent Lamp from a Commercial Standpoint. Edward Weston (E N Y-March 22.) 7000 w.

11500. The Incandescent Lamp Situation.—Letters from F. S. Terry, F. R. Upton, and Others (E W-March 25.) 1500 w.

*11566. Recent Tests of Ferranti Meters (El-March 17.) 600 w.

*11567. The Proposed Municipal Electric Lighting Scheme for Burton-on-Trent. Ill. H. Waring (E E L-March 17.) 1000 w.

11604 The Incandescent Lamp Situation (E W-April 1.) 3800 w.

11605. The Most Economical Age of Incandescent Lamps.—Communications from B. F. Thomas, Elihu Thomson, E. P. Roberts, and W. D. Weaver (E W-April 1.) 2400 w.

11612. Lighting the Biggest Building in the World. Ill. T. C. Martin (E E N Y-March 29.) 2800 w.

11613. The Moore Regulating Lamp Socket for Alternating and Continuous Current. Ill. D. McF. Moore (E E N Y-March 29.) 500 w.

11614. Street Lighting by Private vs. Municipal Plants. Horatio A. Foster (E E N Y-March 29.) 650 w.

11615. A Convertible System of Arc Lighting and Constant Potential Power Service. Ill. S. W. Rushmore (E E N Y-March 29.) 1300 w.

*11763. The Elihu Thomson Watt Hour Meter. G. H. Baillie, W. L. Bayley, C. H. C. Woodhouse (E E L-March 24.) 1000 w.

*11773. The Electric Light in Public Buildings. Alfred H. Gibbings (E R L-March 24.) 1400 w.

11793. The Springfield, Ill., Electric Light and Steam Distribution Plant. Ill. Leslie W. Collins (E E N Y-April 5.) 2500 w.

Serials.

6709. Electric Light and Power. Ill. Arthur F. Guy (E E L-Began Sept. 19—17 parts to date—30 cts. each).

8710. Incandescence Lamp Manufacture in the United States. Leonard G. Tate (E P-Began Dec.—Ended March—3 parts—30 cts. each).

9531. Suggestions for Metering Devices. Ill. S. D. Mott (E W-Began Jan. 14—5 parts to date—15 cts. each).

10844. The Design of a Central Station for Incandescent Electric Lights. E. P. Roberts (E W-Began March 4—2 parts to date—15 cts. each).

11245. The Specification of Electric Plant and Mains for Open Competition. Thomas Tomlinson (E R L-Began March 3—2 parts to date—30 cts. each).

11836. Can a Practical All Solid Incandescent Lamp without Vacuum Be Made? F. M. F. Cazin (E A-Began April 8—1 part to date—15 cts).

GAS ENGINEERING.

11155. Every-day Pyrometry, with Discussion. E. C. Jones (A G L J-March 13) 3500 w.

*11275. Inaugural Address of Pres. W. R. Chester (J G L-March 7.) 4000 w.

11292. Our Map of New York City. Ill. (P A-March 15.) 1000 w.

11360. Notes on Naphthaline. A. H. Stecker (A G L J-March 20.) 2000 w.

11361. A Study in Calculating Heat Units. H. L. Payne (A G L J-March 20.) 700 w.

*11419. Pressure and Luminosity. W. Ivison Macadam (G W-March 11.) 2500 w.

11578. Fitzgerald's Gas Washing and Scrubbing Apparatus. Ill. (A G L J-March 27.) 1400 w.

11579. Kenevel's Process of Gas Manufacture. Ill. (A G L J-March 27.) 2000 w.

*11582. Naphthalene and Benzol in Coal Gas. Prof. Bunte (G W-March 18.) 1600 w.

*11627. Experimenting with a View to the Development of Gasholder Construction.—A Rejoinder. F. Southwell Cripps (J G L-March 21.) 2700 w.

*11628. Inaugural Address of W. Duesbury (J G L-March 21.) 3800 w.

11662. The Present and Future Competition Between Gas and Electricity. Joseph Gwynn (W E-April 1.) 1000 w.

11716. Inaugural Address of C. H. Welch (A G L J-April 3.) 3300 w.

11717. The Present State of the Art of Purification in Closed Vessels, with Discussion. S. F. Hayward (A G L J-April 3.) 5300 w.

11718. A Peculiar Gas-Electric Accident at Indianapolis, Ind. Ill. John R. Pearson (A G L J-April 3.) 600 w.

11722. Should Small Gas Companies Put in Electric Light Plants? with Discussion. H. L. Hurlburt (P A-April 1.) 6500 w.

11723. Is the Wilkinson Process Economical for Small Works? with Discussion. J. F. Seamon (P A-April 1.) 2800 w.

11724. Discrimination by Gas Companies in the Treatment of Their Consumers. G. A. Allen (P A-April 1.) 7400 w.

11792. Two Dangerous Commodities (M N-April 1.) 500 w.

*11825. An Experience with a 24-inch Gas Main. Ill. J. B. Crockett (I S F-April.) 2700 w.

HYDRAULICS.

11176. The Atlantic Highlands, N. J., Standpipe. Ill. (E R-March 11.) 1400 w.

11177. Estimation of the Loss of Water

Power in a Stream by Taking Water for a City Supply. L. M. Hastings (E R–March 11.) 1800 w.

*11217. A High-Speed Waterworks Pump. Ill. Arthur Rigg (Eng L–March 3.) 1800 w.

†11251. The Water Supply of Philadelphia, with discussion. Henry Leffmann (P E C P–Jan.) 13500 w.

†11257. Construction of the Power House of the Rochester Power Company, Adjacent to Genesee Falls, Rochester, N. Y. Ill. Robert Cartwright (T C E–Jan.) 1800 w.

†11258. The Effect of Tuberculation on the Delivery of a 48-in. Water Main. Ill. James Duane (T C E–Jan.) 2000 w.

11308. Stand-Pipes and Their Design. Ill. Freeman C. Coffin (E N–March 16.) 6000 w.

11337. Iron and Steel Water Tanks. W. C. Coffin, Jr. (E M J–March 18.) 1000 w.

11352. The Protection of the Croton Watershed. Peter Milne (F W–March 18.) 900 w.

†11458. Electrolysis of Water Pipes. C. H. Morse (J N E W–March.) 5500 w.

†11459. The High Service Water Works System of New London, Conn. Ill. Walter H. Richards (J N E W–March.) 3000 w.

†11460. Additional Discussion on "The Arrangement of Hydrants and Water Pipes for Protection of a City against Fire." W. R. Billings, G. H. Benzenberg, W. H. Richards, and J. R. Freeman (J N E W–March.) 6500 w.

†11461. Selection of Sands for a Filter. Allen Hazen (J N E W–March.) 2000 w.

†11462. Experience with Cement Lined Pipes. John C. Haskell (J N E W–March.) 2000 w.

11463. Draining the Okefinokee Swamp (Sc A–March 25.) 700 w.

11489. Utilization of Water Power in Southern India (E N–March 23.) 1100 w.

11510. Some Points about Pumps (S E–March 18) 1400 w.

*11570. Drainage of the Valley of Mexico. Ill. (Eng L–March 17.) 1000 w.

*11609. The Water Power at Great Falls, Montana. Ill. (R M–March.) 750 w.

11618. Reasons Given by the Manufacturers for Objecting to the Meter System (W G R–March.) 2000 w.

11619. Strong Endorsement of the Meter System. George H. Felix (W G R–March.) 800 w.

11620. The Meter System Sustained (W G R–March.) 1800 w.

11632. The 5000 H. P. Turbines for the Niagara Power Plant. Ill. (E N–March 30.) 1500 w.

11635. Cost of Laying Water Pipe. C. D. Barstow (E N–March 30.) 3500 w.

11699. The North Adams Dam. Ill. (E R–April 1.) 500 w.

*11759. The Chicago Exhibition Water Supply. (Eng L–March 24.) 1800 w.

*11769. New Waste Gates at Allington Lock. Ill. (E–March 24.) 600 w.

11787. An Ingenious Water-wheel. Ill. (M & B–March.) 950 w.

*11817. Two Methods of Getting Direct High Pressure from Water-Works Pumps. George A. Ellis (P–April.) 2800 w.

11842. Can the So-Called "Underflow" of the Semi-Arid Region be Utilized for General Irrigation? W. W. Follett (E N–April 6.) 4300 w.

*11851. The True Value of a Water Power. (Am M–April 1.) 1400 w.

Serials.

10988. Water-Power Utilization. Ill. W. H. Booth (E L–Began Feb. 24—4 parts to date—30 cts. each).

11202. High-Pressure Hydraulic Presses in Iron Works. Ill. R. M. Daelen (E–Began March 3—Ended March 10—2 parts—30 cts. each).

11373. The New Water Filters at Hamburg. Ill. (E R–Began March 18—Ended March 25—2 parts—15 cts. each).

INDUSTRIAL CHEMISTRY.

†11128. A New Process for the Manufacture of Manganese on the Commercial Scale. William H. Greene and William H. Wahl (J F I–March.) 1500 w.

†11645. Spontaneous Conversion of Isoprene into Caoutchouc. William A. Tilden (I R W–March 15.) 400 w.

*11768. Chlorine Recovery. C. F. Townsend (E–March 24.) 2200 w.

Serials.

11049. The Applications of Ozone (E R L–Began Feb. 24—4 parts to date—30 cts. each).

INDUSTRIAL SOCIOLOGY.

11139. Labor in Europe—Its Condition and How Disputes are Dealt With (B J C–March 11.) 1000 w.

11161. The Movement of Coercion. Justice Brewer (R A–March 10.) 2200 w.

*11165. The Practical Teaching of Industrial Economics (J G L–Feb. 28.) 2000 w.

†11248. The Surplus Gains of Labor. J. B. Clark (An A A–March.) 3200 w.

†11259. Thou Art the Man. Mary Steadman Aldis (C R–March.) 2800 w.

†11260. The Unemployed and the Land. Harold E. Moore (C R–March.) 6000 w.

*11274. More Thoughts Concerning Wealth and Wages (J G L–March 7.) 2000 w.

†11327. The Present Depression of Trade—Opinions of Men of Business (F R–March.) 8000 w.

*11365. The Organization of Labor. T. V. Powderly (Ch–April.) 3800 w.

†11476. Russian Jews as Desirable Citizens. Ida M. Van Etten (F–April.) 5000 w.

†11477. Italian Immigrants and Their Enslavement. S. Merlino (F–April.) 3500 w.

†11507. The Discontent of the Farmer. Edward W. Bemis (J P E-March.) 6500 w.

11521. Labor and Strikes. R. W. R (E M J-March 25.) 800 w.

*11581. The Principles and Practice of Voluntary Arbitration. Edgar Farman (A L-March 17.) 6000 w.

11594. Organized Labor and the Law. The Ann Arbor Strike (R A-March 24.) 1300 w.

*11610. Is Competition the Life of Trade? (R M-March.) 700 w.

†11643. Compulsory Arbitration—A Reply to Dr. Abbott. Chester A. Reed (A-April) 3000 w.

11693. Labor and Competition. R. W. R. (E M J-April 1.) 1000 w.

†11707. The Negro as a Mechanic. Robert Lowry (N A R-April.) 2000 w.

11708. Organized Labor and the Law. W. L. W. (R A-March 31.) 850 w.

*11725. The Eight-Hour Day. How Will It Affect Wages? (R R L-March 24.) 1800 w.

11735. Labor Troubles in the Mines. Editorial (M I T-March 30.) 850 w.

LANDSCAPE ENGINEERING.

11247. Formal Gardening: Does It Conflict with the Natural Style? (G & F-March 15.) 1300 w.

11442. Formal Gardening: Where it Can Be Used to Advantage (G & F-March 22.) 1500 w.

MARINE ENGINEERING.

11134. The French Man-of-War "Dévastation." Ill. (M Rec-March 9.) 125 w.

†11167. East Indian Railway Steamer Lakshmi. Ill. A. W. Rendell (I E-Feb. 4.) 750 w.

*11169. Electrical Distribution for Marine Purposes (M E-March 1.) 1000 w.

*11185. Marine Boilers. Editorial (E-Feb. 24.) 5200 w.

*11187. The Mercantile Marine in War. Editorial (E-Feb. 24.) 2200 w.

*11199. The British Mercantile Marine. Editorial (E-March 3.) 700 w.

11286. A Valuable Aid to Navigation—The Solarometer (Sea-March 16.) 600 w.

11287. Amended Steamboat Rules (Sea-March 16.) 2000 w.

11289. The Use of Oil at Sea. Ill. (Sc A S-March 18.) 500 w.

11297. Screw Propeller—Easy Method of Measuring the Pitch. Ill. (Ir Age-March 16.) 1600 w.

*11400. Wire Shafts for Steamers (I-March 10.) 500 w.

*11407. The Launching of the Campania and Lucania. Ill. (Eng L-March 10.) 3200.

*11410. Southampton and the American Line of United States Mail Steamers. Ill. (Eng L-March 10.) 2000 w.

*11427. Electric Side-Lights on Ships (El-March 10.) 800 w.

11469. British War Ship Construction (Ir Age-March 23.) 1400 w.

11491. Jetty Harbors of the Pacific Coast. Thomas W. Symons (E N-March 23.) 1300 w.

11497. The Steamship "Fuerst Bismarck," Hamburg-American Line. Ill. (E N-March 23.) 1000 w.

11520. The Engineer and the Modern Steamship (M R C-March 23.) 2000 w.

11533. Description of the Engines for the Steamer "Manitou." Ill. (M Rec-March 23.) 700 w.

*11576. Experimental Apparatus and Shaping Machine for Ship Models. Ill. R. E. Froude (I L-March 17.) 2700 w.

†11705. Shipbuilding Here and Abroad (N A R-April.) 3000 w.

11714. The Accident to the "Noordland" S. S. (Eng-April 1.) 1750 w.

*11757. The Loss of the "Naronic." Ill. Editorial (Eng L-March 24.) 1200 w.

*11778. French Protection against British Shipping (Tr-March 24.) 850 w.

11831. Wilmington's Quadruple Event. Three Launches and a Trial Trip (Sea-April 6.) 2000 w.

11832. Queen of the Chesapeake. The Alabama. Ill. (Sea-April 6.) 1000 w.

11838. The Free Port of Copenhagen (E N-April 6.) 2400 w.

Serials.

8483. Marine Engine Design. W. F. Durand (M R C-Began Dec. 1—4 parts to date—15 cts. each).

10888. Marine Propulsion. Ill. I. McKim Chase (A M-Began March 2—3 parts to date—15 cts. each).

11127. Resistance to Ship's Motion: A Natural Law Newly Discovered. F. M. F. Cazin (J F I-Began March—2 parts to date—45 cts. each).

11215. History of the Cunard Steamship Company. Ill. (Eng L-Began March 3—Ended March 10—2 parts—30 cts. each).

11230. Hints to Intending Sea-going Engineers (M W-Began March 3—Ended March 24—2 parts—30 cts. each).

11307. The American Sailor. Percy W. Thompson (Am S-Began March 16—4 parts to date—15 cts. each).

11392. The Central Marine Engine Works at West Hartlepool. Ill. (E-Began March 10—Ended March 17—2 parts—30 cts. each).

MECHANICAL ENGINEERING.

†11125. Duty Trial of a Pumping Engine Built by The George F. Blake Manufacturing Company. Ill. Cecil H. Peabody (J F I-March.) 3500 w.

11149. Copying Machinery. B. F. Spalding (A S-March 11.) 2000 w.

*11229. Variable-Speed Power Transmission. Ill. H. C. Spaulding (M W-March 3.) 1400 w.

†11249. The Distribution of Pressure in Bearings. Ill. Carl G. Brath (P E C P-Jan.) 3800 w.

†11250. Investigation of the Strength of Gear Teeth. Ill. Wilfred Lewis (P E C P-Jan.) 2500 w.

11294. The Strength of Small Chains. Ill. (Ir Age-March 16.) 450 w.

11295. Proportioning a Compound Air Compressor (Ir Age-March 16.) 1000 w.

11347. Defects of Air Compressors. W. J. Jenkins (Eng-March 18.) 900 w.

11349. The "Tool Post Grinder" and Some of Its Uses. Ill. (A M M-March.) 2000 w.

11368. A New Ice Machine. F. van Gerpen (B J C-March 18.) 1000 w.

*11406. The Stanners Closes Steel Works, Wolsingham. Ill. (Eng L-March 10.) 3200 w.

*11424. The German Elmore Works. Ill. Clarence P. Feldmann (El-March 10.) 900 w.

11535. Marvelous Mechanism. Wonderful Timepiece Constructed by a Connecticut Manufactory (B J C-March 25.) 550 w.

11622. Pulverization. Ill. (Sc A S-April 1.) 1800 w.

11625. The Cost and Value of Compressed Air. Frank Richards (A M-March 30.) 1000 w.

*11667. Re-Keying on Eccentric Sheaves in Wheel-Shop. Ill. A. A. Maver (L E-April.) 700 w.

*11668. Causes of Breakage. Editorial (L E-April.) 1400 w.

*11669. Tempering Tools. Ill. W. G. Lottes (L E-April.) 900 w.

*11671. Tools for Blacksmith Work. Material and Its Uses. George F. Hinkins (L E-April.) 1200 w.

11712. The Reese Universal Beam Mill. Ill. (Ir Age-March 30.) 3000 w.

*11728. The Jointing of Cast-Iron Pipes (E L-March 24.) 1000 w.

*11733. The "Cyclone" Dust Collector. Ill. C. V. Boys (I L-March 24.) 2000 w.

†11819. The Modern Traveling Crane. Ill. Alexander E. Outerbridge, Jr. (J F I—April.) 4300 w.

*11850. Mistaken Ideas of Shafting. C. B. Tompkins (Am M-April 1.) 1200 w.

Serials.

11039. Helico-Centrifugal Ventilator (C G-Began Feb. 24—Ended March 3—2 parts—30 cts. each).

11082. Belts.—The Influence of Speed.—Dimensions of Pulleys. Charles A. Hague (E A-Began March 11—2 parts to date—15 cts. each).

11246. Mechanical Engineering Materials. Ill. Edward C. R. Marks (P Eng-Began March 3—2 parts to date—30 cts. each).

11569. The Mannesmann Process of Seamless Tube Rolling. W. H. Barraclough (M W-Began March 17—1 part to date—30 cts).

11654. Core Making. Ill. S. Rolland (I T R-Began March 30—1 part to date—15 cts.)

METALLURGY.

11124. The Electrolytic Refining of Copper.—Translated from the French of M. Hyppolyte Fontaine (E M J-March 11.) 700 w.

11148. Experiments with Foundry Iron and Aluminum. C. G. Taylor (A S-March 11.) 1200 w.

*11207. Manganese.—New Estimation Method (I-March 3.) 800 w.

*11278. A Model Coke Plant.—The Oliver Coke Works near Uniontown, Pa. Ill. (C E-March.) 2200 w.

†11301. The Calculation of Lead Blast-Furnace Charges. H. Van F. Furman (S M Q-Jan.) 4400 w.

11333. Steel Making in the South (E M J-March 18.) 1100 w.

11335. The General Arrangement of a Lead Smelting Plant. Ill. H. O. Hofman (E M J-March 18.) 1000 w.

†11380. Traces of a Vanished Industry. John Gifford (P S M-April.) 1500 w.

*11387. An Investigation of Coals for Making Coke in the Semet Solvey Ovens, with the Recovery of Ammonia and Tar; and Remarks on the Sources of Ammonia. J. D. Pennock (C G-March 10.) 2000 w.

*11395. Alloys (E-March 10.) 1300 w.

*11399. Treating Refractory Metals in the Electric Furnace (I-March 10.) 700 w.

*11423. What Is Put into a Blast Furnace. Walter J. May (Inv-March 11.) 1000 w.

11453. Big Castings in Little Foundries. Ill. S. Bolland (F D-March 10.) 2000 w.

11454. Pig Iron.—An Account of the Blast Furnace Process by Which the Ores are Reduced to Pig Iron (F D-March 10.) 1700 w.

11464. The Robinson Rifle. Ill. (M S P-March 18.) 400 w.

11467. About Steel. S. W. Goodyear (A M-March 23.) 2000 w.

11471. The Birmingham Steel Question (Ir-Age-March 23.) 1100 w.

11523. The Cost of Barrel Chlorination. John E. Rothwell (E M J-March 25.) 500 w.

11525. Notes on the Cyanide Process in South Africa. W. G. Shaw (E M J-March 25.) 800 w.

*11584. Notes on Modifications of a Method for the Rapid Estimation of Phosphorus. Walter Macfarlane and Archibald Wilson (I C T-March 17.) 3500 w.

11651. Marquette as a Pig Iron Producer. Richard A. Parker (I T R-March 30.) 4300 w.

11652. Chicago as an Iron Center (I T R-March 30.) 2200 w.

11695. The Campbell Washing Machine as Used on Copper Ores (E M J-April 1.) 1500 w.

11696. The Losses in Dressing Cornish Tin Ores. Ill. (E M J-April 1.) 500 w.

11697. Volumetric Determination of Lead. H. H. Alexander (E M J-April 1.) 700 w.

*11737. Electric Metal-Working Development. Frederick P. Royce (I-March 24.) 3700 w.

*11738. Determination of Phosphorus in Iron and Steel. Adolphe Carnot (I-March 24.) 1000 w.

*11739. Canadian Platiniferous Nickel. F. W. Clarke and Charles Catlett (I-March 24.) 800 w.

*11746. The Recent Movement of Iron and Steel Prices in Germany (C G-March 24.) 1200 w.

*11747. The Probability of Establishing an American Tin-Plate Industry (C G-March 24.) 1200 w.

11790. Shrinkage and Warping of Castings. C. R. Tompkins (M N-April 1.) 1300 w.

*11824. Amalgamating Silver Mill, Santa Ediuwiges, Chihuahua, Mexico. Ill. (I S F-April.) 550 w.

*11826. The Invention of Cast Steel (I S F-April.) 2500 w.

Serials.

9459. The Manufacture of Coke. Ill. John Fulton (C E-Began Jan.—4 parts to date—30 cts. each).

10254. Manganese Steel. Ill. Henry M. Howe (J F I-Began Feb.—Ended March—2 parts— 45 cts. each).

10892. Some Points in Silver Milling by Amalgamation. C H. Aaron (M S P-Began Feb. 25—4 parts to date—15 cts. each).

10971. Resistance of Metals to Shear. H. V. Loss. (A E R J-Began March—2 parts to date—30 cts. each).

11122. Variations in the Milling of Gold Ores.—Otago, New Zealand (E M J-Began March 11—Ended March 18—2 parts—15 cts. each).

11219. The Manufacture of Steel by the Thomas and Gilchrist Process. F. Fordeur (C G-Began March 3—Ended March 17—3 parts—30 cts. each).

11222. The Coking of Coal. M. Rossigneux (C G-Began March 3—Ended March 17—3 parts—30 cts. each).

11466. How to Repair Broken or Cracked Castings. Ill. S. Bolland (A M-Began March 23—2 parts to date—15 cts. each.)

11650. Lake Coke-Making and the Weathering of Connellsville Coal. Edmund C. Pechin (I T R-Began March 30—Ended April 6—2 parts—15 cts. each).

11736. The American Tin-Plate Industry (I-Began March 24—1 part to date—30 cts).

MILITARY ENGINEERING.

*11193. The Mounting of Navy Guns. Editorial (E-Jan. 27.) 1500 w.

*11198. The Navy Estimates. Editorial (E-March 3.) 5000 w.

11296. Hydraulic Machinery and Heavy Guns (Ir Age-March 16.) 600 w.

11298. The Schneider Gun Mount. Ill. (Ir Age-March 16.) 600 w.

11310. A Bill to Reorganize the Corps of Civil Engineers, U. S. Navy, with Editorial (E N-March 16.) 1700 w.

*11367. The Year's Development of the New Navy (Ch-April.) 1000 w.

11456. Hiram S. Maxim. Ill. (M N-March 15.) 1800 w.

11480. The Simplex and Huge Torpedoes. Ill. H. C. Vogt (Sc A S-March 25.) 1700 w.

11511. Armor Plate and Projectile Tests (B I S-March 22.) 750 w.

*11583. The Finspong Ordnance Factory (I & S-March 18.) 2400 w.

*11588. The Navy and the Lords. Editorial (E-March 17.) 3500 w.

†11706. How Shall the Pension List Be Revised? R. P. C. Wilson, S. S. Burdett, and W. C. Church (N A R-April.) 6000 w.

*11752. Shells with High Explosives. Ill. (A E R J-April.) 1400 w.

*11758. The Bearing of Recent Plate Trials on Future Warfare. Editorial (Eng L-March 24.) 1200 w.

*11760. The Russian Official Report on the Ochta Competition. Ill. (Eng L-March 24.) 1000 w.

Serials.

8241. Assault and Battery. Ill. A. Ewbank (I E-Began Oct. 22—Ended Feb. 25—15 parts—45 cts. each).

10738. The Development of American Armor Plate. Ill. F. Lynwood Garrison (M-Began Feb. 15—2 parts to date—30 cts. each).

10957. Chinese Curios. Edward Bedloe (A A-Began March 4—Ended March 11—2 parts—15 cts. each).

11470. Trial of the Dynamite Gunboat "Vesuvius" (Ir Age—Began March 23—Ended March 30—2 parts—15 cts. each).

MINING.

*11103. The Gold Fields of Dutch Guiana. Ill. A. I. Mather (E Mag-May.) 3000 w.

11112. "The Coal Fields of Texas." W. F. Cummins (M R-March 10.) 1500 w.

11121. The Albert Silver Mine, South Africa. Ill. (E M J-March 11.) 1600 w.

11123. The Occurrence of Manganese Ore in Veins. Edward Halse (E M J-March 11.) 1800 w.

*11220. Costs of Coal and Ore Washing. Walter J. May (C G-March 3.) 3500 w.

*11221. Restricted Production (C G-March 3.) 1000 w.

11223. Notes on the Formation of the Iron Ores. James D. Robertson (Sc-March 10.) 800 w.

*11262. The New Kohinoor Gold and Silver

Mine (N. S. W.) Ill. (A M S-Jan. 28.) 2000 w.

*11263. Platinum Deposits at Broken Hill. J. B. Jaquet (A M S-Jan. 28.) 2500 w.

*11276. The Lead and Zinc Mines of Southwest Missouri—A Description of the Ore Formations, and the Primitive Methods of Mining. F. C. Florance (C E-March.) 1200 w.

*11277. Gold Mining in the West. John Robertson (C E-March.) 1400 w.

*11279. Grades for Haulage and Drainage. Richard Lewis (C E-March.) 1100 w.

*11281. 1800 Pounds Equal 1 Ton, According to the Rules of New York Coal Yard Proprietors. H. Barring (C E-March.) 4800 w.

*11283. Advantageous Construction of the Transit and Its Tripod. Ill. Otto C. Burkhart (C E-March.) 1300 w.

*11284. The Use and Characteristics of Explosives Used in Metal Mining. M. C. Ihlseng (C E-March.) 1100 w.

11293. The Boom in Coal Lands (P A-March 15.) 900 w.

†11303. Notes on the Huanchaca Mine, Bolivia, S. A. Robert Peele, Jr. (S M Q-Jan.) 1100 w.

11304. The Situation at Cœur D'Alene (M S P-March 11.) 1300 w.

11306. A California Mine Owned by Ladies (M S P-March 11.) 800 w.

11317. The Lease or Tribute System of Mining as Practised in Colorado. Benjamin B. Lawrence (E N-March 16.) 900 w.

11323. Cuban Iron Ores. Edmund C. Pechin (I T R-March 16.) 2700 w.

11334. Draining Dip Workings. Ill. H. F. Bulman (E M J-March 18.) 2000 w.

11357. A New Process to Utilize Coal Refuse (M R-March 17.) 1000 w.

11372. Rico and the Enterprise Mine. Ill. (M I T-March 16.) 3500 w.

11378. Profits in Coal Mining (T-March 15.) 900 w.

*11382. Electric Light Switches for Use in Mines. Sydney F. Walker (C G-March 10.) 1800 w.

*11384. The Costs of Handling Ore and Coal. Walter J. May (C G-March 10.) 800 w.

*11434. Opals (A M S-Feb. 11.) 1200 w.

*11438. The Victory Gold Mine, Charters Towers (Q.) (A M S-Feb. 18.) 900 w.

*11440. The Broken-Hill Proprietary Company (A M S-Feb. 18.) 1200 w.

11472. The Styrian Magnesite Deposit (Ir Age-March 23.) 650 w.

11517. Labor Department Report on the Phosphate Industry (M R-March 24.) 1000 w.

11522. The Norfolk and Western-Pocahontas Combine (E M J-March 25.) 1200 w.

11524. The Coal Washing Plant at Brookwood, Ala. Ill. (E M J-March 25.) 700 w.

*11549. Coal Mining in Wyoming. William Job (C G-March 17.) 1200 w.

*11556. Tubbing for Pit Shafts. Ill. A Mining Engineer (P Eng-March 17.) 600 w.

*11558. Charters Towers Goldfield. Facts and Opinions of a Recent Visitor (Min W-March 18.) 1500 w.

*11559. Gold Mining in India. A. Mervyn Smith (Min W-March 18.) 2200 w.

11623. Neglect of the Mining Industry in California. Old Californian (M S P-March 25.) 800 w.

11624. "Machine" Mining in Wyoming (M S P-March 25.) 700 w.

11653. Soft Ore Mining on Lake Superior. Per Larsson (I T R-March 30.) 1300 w.

11694. The Coal Fields of Vancouver Island. James Ormiston (E M J-April 1.) 450 w.

*11748. Determination of the Calorific Power of Various Coals, with Abstraction of the Vaporization and Hygroscopic Water. Pierre Mahler (C G-March 24.) 800 w.

*11803. An Exception to the Rule—An Occurrence of Coarse Conglomerate above the Mammoth Anthracite Bed. Benjamin Smith Lyman (C E-April.) 1500 w.

*11805. The Examination of Mine Inspectors and Mine-Foremen. Editorial (C E-April.) 550 w.

*11807. Calculations Pertaining to Hoisting Appliances. F. W. Ewald (C E-April.) 1000 w.

11843. Electrical Coal Mining (E N-April 6.) 2500 w.

11848. The Indiana Gas Field. A. A. A. (I T R-April 6.) 1300 w.

Serials.

8520. Notes on Ironstone Mining in Cleveland. J. C. l'Anson (E-Began Nov. 25—2 parts to date—30 cts. each).

9003. Diamonds in India. A Rechauffée. W. King (I E-Began Nov. 19—4 parts to date—45 cts. each).

10478. The Denbighshire Coalfield. M. E. (C G-Began Feb. 3—3 parts to date—30 cts. each).

10584. Scientific Phases of Mining. Albert Williams, Jr. (Ch-Began March—Ended April—2 parts—30 cts. each).

10645. Croydon (N. Q.) (A M S—Began Jan. 14—3 parts to date—30 cts. each).

10978. The Lührig Process of Washing and Testing Coal. James l'Anson (I-Began Feb. 24—Ended March 3—2 parts—30 cts. each).

11282. Mine Ventilation Made Easy. W. Fairley (C E-Began March—2 parts to date—30 cts. each).

11285. Theories Regarding the Origin of Ore Deposits. Ill. Arthur Lakes (C E-Began March—Ended April—2 parts—30 cts. each).

11385.—Selecting and Calculating a Fan, with Tests of Rateau Fans. M. Rateau (C G-Began March 10—2 parts to date—30 cts. each).

11386. Correlation of the Coalfields in the North of France and South of England. Marcel Bertrand (C G-Began March 10—Ended March 17—2 parts—30 cts. each).

11433. The Hillgrove Mines (A M S-Began Feb. 4—3 parts to date—30 cts. each).

11436. Dalmorton (A M S—Began Feb. 11—2 parts to date—30 cts. each).

11537. Natural Gas. John Young (A M & I W-Began March 24—2 parts to date—15 cts. each).

11574. The Mineral Resources of the Southern States. Ill. (I L-Began March 17—1 part to date—30 cts).

11801. Information to Aid in the Search for Gold and Silver. Ill. Arthur C. Lakes (C E-Began April—1 part to date—30 cts).

11804. Fire-Damp. H. Le Chatelier. Translated by H. H. Stock (C E-Began April—1 part to date—30 cts).

11820. From Mine to Furnace. John Birkinbine (J F I-Began April—1 part to date—45 cts).

RAILROADING.

*11101. The Gravity System of Rapid Transit. Benj. S. Henning (E Mag-May.) 3000 w,

*11104. The Cost of Street-Railway Building. T. William Harris (E Mag-May.) 3000 w.

11113. Neatness and Economy at Small Stations. G. C. H. (R G-March 10.) 1100 w.

11114. A Bridge Accident in Massachusetts.—The Accident which Occurred on the Fitchburg Railroad, Feb. 11, 1892. George E. Swain (R G-March 10.) 2500 w.

11115. Union Passenger Station at Portland, Oregon. Ill. (R G-March 10.) 600 w.

11116. Draft Rigging. Chicago, Burlington and Quincy Box Cars. Ill. (R G-March 10.) 600 w.

11118. A Hard Winter and Heavier Rails. C. P. Sandberg (R G-March 10.) 700 w.

11119. The 100-Miles an Hour Electric Railroad. Editorial (R G-March 10.) 2200 w.

11120. Some German Ideas on Railroad Ties. Ill. (R G-March 10.) 1400 w.

11151. The Co-relation of the Public, the Railways, and Organized Labor. H. H. Porter (R R-March 11.) 1800 w.

11152. Duties of Track and Bridge Men (R R-March 11.) 700 w.

11153. Krupp's Special Railway Car for Transporting Heavy Guns. Ill. (R R-March 11.) 700 w.

11154. Is Further Increase of Freight Equipment Necessary? (R R-March 11.) 1600 w.

11157. Some Early Railway Brakes. Ill. (R C J-March.) 700 w.

11158. Car Building on the Pacific Coast (R C J-March.) 1500 w.

11159. Safety Appliance Legislation. H. S. Haines (R C J-March.) 1500 w.

11160. Some Considerations Concerning Track Elevation. Editorial (R A-March 10.) 700 w.

11162. The Track Elevating Ordinance.—Letters from T. B. Blackstone and C. H. Chappell (R A-March 10.) 900 w.

11163. Removing a Rock. H. O. Granberg (R A-March 10.) 2000 w.

11175. Underground Rapid Transit in London (E R-March 11.) 700 w.

*11189. Compound Express Locomotive for the Northern Railway of France (E-Feb. 24.) 2100 w.

*11233. Railways Past and Present. Editorial (E L-March 3.) 1200 w.

†11252. High Speed on Railways—From a Maintenance of Way and Engineering Standpoint, with Discussion. Charles S. Churchill (P E C P-Jan.) 6500 w.

11264. Some Details of a New English Cable Road (S R G-March 11.) 600 w.

11265. Page's Elevated Conduit Railway and Bicycle Course. Ill. (S R G-March 11.) 250 w.

11290. The New Law for Brakes and Car Couplers (Sc A-March 18.) 900 w.

11312. The Boston Rapid Transit Situation. Ill. (E N-March 16.) 3500 w.

11316. The Proposed Street Railway Tunnel under Boston Common (E N-March 16.) 400 w.

11339. The Speed and Capacity of Rapid Transit Roads in Cities. Ill. J. James R. Croes (R G-March 17.) 600 w.

11340. The Rogers Compound Locomotive on the Illinois Central. Ill. (R G-March 17.) 1100 w.

11341. Slater and Barnes' Highway Crossing Bells. Ill. (R G-March 17.) 1200 w.

11342. Average Speed of Rapid Transit Trains. Editorial (R G-March 17.) 3000 w.

11350. Improvements to Broad Street Station, Pennsylvania Railroad, Philadelphia. Ill. (R A-March 17.) 700 w.

11351. Heating Elevated Cars in Chicago (R A-March 17.) 1100 w.

*11353. Racine's Street Railway. Ill. (S R R-March.) 1200 w.

*11354. Electric Traction in 1850 (S R R-March.) 900 w.

*11355. The Invention of the Cable Railway. Ill. (S R R-March.) 3000 w.

*11394. A Concrete History of the Railway. Editorial (E-March 10.) 2300 w.

11412. Where the Money Goes. Finance (R R-March 18.) 800 w.

11413. Train Resistance. William Forsyth (R R-March 18.) 450 w.

11414. Changes in Iron Subsequent to Manufacture and their Relation to Rail Joints. D. E. Bishop (R R-March 18.) 1100 w.

11415. Some Notes of Florida Travel (R R-March 18.) 700 w.

11416. Authority of a State over Fast Mail Passenger Trains. Editorial (R R-March 18.) 750 w.

11417. The Oldest German Railway. Dr. Jchenhaeuser (R R-March 18.) 700 w.

11420. Municipal Corporations. R. D. Fisher (S R G-March 18.) 2500 w.

11421. Will the Closed Conduit Supersede the Trolley in Large Cities. Ill. Frank C. Perkins (S R G–March 18.) 1100 w.

11484. English Saloon Cars (E N–March 23.) 1500 w.

11487. Landslides on the Bolan Railway, India (E N–March 23.) 600 w.

11490. Zone System of Railway Fares in Ireland (E N–March 23.) 350 w.

11492. The Mayor of Boston on Rapid Transit (E N–March 23.) 2500 w.

11493. American and English Railway Cars (E N–March 23.) 1200 w.

11494. Automatic versus Manual Block Signals. John P. O'Donnell (E N–March 23.) 2000 w.

†11506. The Railway Policy of Prussia. Gustav Cohn (J P E–March.) 4600 w.

*11516. Gas Lighting in Railway Carriages (G E M–March 10.) 2000 w.

11518. Railroad Building in West Virginia (M R–March 24.) 1500 w.

11528. The Engineers' Strike and Boycott at Toledo (R G–March 24.) 1000 w.

11530. The Ferro-Carril Central Del Peru. Ill. (R G–March 24.) 1000 w.

11531. Qualifications and Responsibilities of a General Passenger Agent. G. H. Heafford (R G–March 24.) 1700 w.

11532. Judge Rick's Injunction Against the Locomotive Engineers. Editorial (R G–March 24.) 1350 w.

*11561. Variable Gear for Electric Traction. Ill. (El–March 17.) 1200 w.

11595. The Protection of Railroad Interests. James F. How (R A–March 24.) 2000 w.

11596. Railroad Interests Must Combine. J. C. Clarke (R A–March 24.) 900 w.

11598. Progress of the Elevation of the Tracks of the Illinois Central Railroad (R R–March 25.) 1000 w.

11599. Lumbermen's Losses and Railway Monopolies. A. H. Winchester (R R–March 25.) 2200 w.

11600. A Model of Railroad Organization (R R–March 25.) 2000 w.

11602. An Electric Car Trial. Frederick Bedell (E W–April 1.) 500 w.

11636. Heavier Rails. C. P. Sandberg (E N–March 30.) 1200 w.

11639. Moving a Bridge by Rail. Ill. (Sc A–April 1.) 450 w.

11640. The Legal Status of Railroad Employés. Editorial (Sc A–April 1.) 1000 w.

11663. Modern Rails. Editorial (R G–March 31.) 1700 w.

11664. Delays of Freight in Yards (R G–March 31.) 850 w.

*11672. Do Our Side Rods Use Up 800 Horse Power of the Locomotive? A criticism of W. Barnet Le Van's article on "Increased Speed in Railway Travel," published in the March number of the Engineering Magazine. American (L E–April.) 950 w.

*11673. Notes on the Railways of Northern Italy. Walter Lodia (L E–April.) 1400 w.

*11674. Train-Running under the Confederacy. Carter S. Anderson (L E–April.) 3000 w.

*11675. Bursting Up a Railroad. Dyce Conveth (L E–April.) 3300 w.

*11676. Merits of Diamond Stacks and Extension Fronts (L E–April.) 600 w.

†11679. The Houston Street Station of the Broadway, New York, Cable Railway. Ill. (S R J–April.) 1100 w.

†11680. The New Brooklyn Station of the New York and Brooklyn Bridge. Ill. (S R J–April.) 1000 w.

†11681. Accident at the Lowell and Suburban Street Railway Station, Lowell, Mass. Ill. (S R J–April.) 500 w.

†11682. In the Matter of Rail Joints. Motor (S R J–April.) 2000 w.

†11683. Method of Engaging Employés. Denver Tramway Company (S R J–April.) 2500 w.

†11684. Car Equipment Tests. Ill. Charles F. Uberlacker (S R J–April.) 6500 w.

†11685. Electric Railroads. John C. Henry (S R J–April.) 3000 w.

*11703. Cross Ties for Railway Bridges, with Discussion. James Ritchie (J A E S–Feb.) 3000 w.

11709. Locomotive Efficiency (R A–March 31.) 1000 w.

11710. The M. C. B. Type of Coupler. A. M. Waitt (R A–March 31.) 2000 w.

*11721. A System of Economizing Oil. J. B. Michael (N C B–April.) 1200 w.

*11730. Locomotive Building at Crewe. Ill. (R W–March.) 8000 w.

*11731. A Railway Paradox (R W–March.) 1200 w.

*11732. The Hong Kong Cable Tramway. Ill. (R W–March.) 1600 w.

11740. Hedges as Snow and Sand Fences. Jerry Sullivan (R R–April 1.) 700 w.

11741. Special Application of Automatic Block Signals. Ill. (R R–April 1.) 600 w.

11742. Cost of Equipping Railroads with Automatic Couplers. Jos. A. Shinn (R R–April 1.) 800 w.

11743. The Maintenance of Existing Commercial Channels. Editorial (R R–April 1.) 850 w.

11744. The Law of Flying Switches. Editorial (R R–April 1.) 1000 w.

*11751. The Comforts of Railroad Travel (A E R J–April.) 3700 w.

*11753. The Locomotive Problem. Ill. C. H. Lindenberger (A E R J–April.) 1000 w.

*11756. The System of Electric Car Lighting on the Jura-Simplon Railway. Ill. (A E R J–April.) 1700 w.

11791. Possibilities in Rapid Transit, J. Murray Case (M N–April 1.) 900 w.

11797. Electric Heater for Cars. Ill. (S R N–April 1.) 1400 w.

Serials.

7456. The Locomotive Boiler. Ill. Gustav Richard (A J R A-Began Oct.—5 parts to date—30 cts. each).

9254. Railway Management. Horace Cope (R R-Began Dec. 31—4 parts to date—15 cts. each).

9689. Railroad Car Design. Ill. Archer Richards (R C J-Began Jan.—2 parts to date—15 cts. each).

10378. The Evolution of the Railroad Turntable. Ill. C. A. Greenleaf (R G-Began Feb. 10—3 parts to date—15 cts. each).

10502. English and American Railways. W. M. Acworth (E Mag-Began April—2 parts to date—30 cts. each.)

11007. The Transcontinental Railways. Edward P. Vining (R R—Began March 4—Ended March 11—2 parts—15 cts. each).

11184. The Berne Compressed Air Tramway. Ill. C. S. DuRiche Preller (E-Began Feb. 24—Ended March 3—2 parts—30 cts. each).

11568. The Possibilities of High Speed Electric Traction. Frank B. Lea (El-Began March 17—Ended March 24—2 parts—30 cts. each).

SANITARY ENGINEERING.

*11098. The Cholera Prospect in 1893. D. B. St. John Roosa (E Mag-May.) 3000 w.

11130. Lining Tanks with Copper. Ill. John Fuller (Met W-March 11.) 2500 w.

11174. Cremating Garbage. W. F. Morse (A A-March 11.) 2800 w.

11178. Cost of Maintaining Small Separate Sewers (E R-March 11.) 1200 w.

11181. Ventilation and Heating. W. G. Blish (A Ar-March 11.) 2200 w.

†11255. Flood Waves in Sewers and Their Automatic Measurement, with Discussion. Ill. Alva J. Grover (T C E-Jan.) 2000 w.

11344. Ventilation. D. H. Smith (Met W-March 18.) 900 w.

11359. Latrines of the East. Ill. Edward S. Morse (A A-March 18.) 5200 w.

11374. Sewerage Systems as Municipal Investments (E R-March 18.) 700 w.

11418. Plumbing in the World's Fair. Ill. (D E-March 17.) 1800 w.

11488. The Engle System of Garbage Cremation (E N-March 23.) 1000 w.

*11514. The Immigration of Destitute Aliens (S R-March 15.) 1600 w.

*11515. Purification of Public Buildings (G E M-March 10.) 1900 w.

*11543. The Treatment of Manufacturers' Waste Waters (C T J-March 18.) 2500 w.

11590. The Memphis Sewerage System (E R-March 25.) 1500 w.

11592. A Movement for Municipal Sanitation (E R-March 25.) 1400 w.

11659. The Smead System of Ventilation. J. T. Oster (A & B-April 1.) 900 w.

*11688. Rules for House Sanitation and Drainage. R. F. Middleton (N P R-April.) 1400 w.

11847. Sturtevant System of Heating and Ventilating. Ill. (M R-April 7.) 900 w.

Serials.

5358. Sewage Purification in America. Ill. (E N-Began July 14—25 parts to date—15 cts. each).

8127. Ventilation and Heating. J. S. Billings (E R-Began Nov. 19—6 parts to date—15 cts. each).

9725. The Chemical Bacteriology of Sewage; Its Hygienic Aspect. W. E. Adeney (Pl D-Began Jan. 2—3 parts to date—30 cts. each).

10425. A Healthy Home. Francis Vacher (S R-Began Feb. 1—4 parts to date—30 cts. each).

10641. Purifying Water for Household Supply (S P-Began Feb. 15—2 parts to date—15 cts. each).

10942. The New York Plumbing Regulations. A. H. Napier (E R-Began March 4—2 parts to date—15 cts. each).

11166. Mr. Doig's Report on the Shone System at Rangoon. Scrope B. Doig (I E-Began Feb. 4—2 parts to date—45 cts. each).

11376. Plumbing in the New Netherlands' Hotel. Ill. (E R-Began March 18—1 part to date—15 cts).

11687. The Moral, Mental, and Physical Necessities of Ventilation. P. C. Remondius (N P R-Began April—1 part to date—30 cts).

STEAM ENGINEERING.

11140. A Universal Calorimeter. Ill. (B J C-March 11.) 1200 w.

11141. Firing Boilers (B J C-March 11.) 700 w.

*11146. Rules and Regulations for the Supply of Electricity, Steam, Compressed Air, and Power from Shafting (W F E E-March.) 1800 w.

†11164. Tests on the Triple Engine at the Massachusetts Institute of Technology. Ill. C. H. Peabody and E. F. Miller (T Q-Oct.) 2200 w.

*11231. Piston Rod Packings (M W-March 3.) 1000 w.

†11254. The Development of the Injector. Ill. Strickland L. Kneass (P E C P-Jan.) 2600 w.

11299. "Residuum" as Fuel and the Practical Results Obtained. Ill. F. G. Gasche (S E-March 11.) 2600 w.

11321. The "Devaporator." Ill. (S V-March 15.) 2000 w.

†11328. The Cost of Steam Power Produced with Engines of Different Types under Practical Conditions; with Supplement Relating to Water Power. Charles E. Emery (T A I E E-March.) 11500 w.

11343. Steam Hot-Blast Apparatus. Ill. Walter B. Snow (Met W-March 18.) 2000 w.

11345. The Piping of Cross Compound Engines. Ill. E. A. Blackwell (Eng-March 18.) 700 w.

11362. Water. W. H. Wakeman (M G-March 18.) 1000 w.

11369. The Compound Engine—Wherein Are Its Economics (B J C-March 18.) 800 w.

11370. Difficulties with Injectors (B J C-March 18.) 1000 w.

11371. High Steam Pressure—Wherein Its Use Often Becomes Uneconomical (B J C-March 18.) 700 w.

11455. Steel Boiler Tubes (M N-March 15.) 600 w.

11457. Electrically Welded Boilers (M N-March 15.) 400 w.

*11479. Economy of Automatic Engines. Ill. R. H. Thurston (S J E-March.) 1800 w.

11498. Henry R. Worthington and the Evolution of Steam Pumping Engines. Ill. (E N-March 23.) 5500 w.

11509. The Smoke Question—Opposition of the Chicago Citizens' Protective Association (S E-March 18.) 2000 w.

11534. Some Queer Ideas. W. H. Wakeman (M G-March 25.) 1000 w.

11536. The Distribution of Heat in Boilers. Lawrence Woodland (B J C-March 25.) 600 w.

*11557. The Value of Indicator Diagrams. Ill. Richard Thompson (P Eng-March 17.) 700 w.

*11573. The Efficiency of Steam Engines. Editorial (Eng L-March 17.) 2100 w.

*11656. Firing (A J R A-March.) 1400 w.

*11666. Some Experience with Balanced Slide-Valves. Ill. John H. Cooper (L E-April.) 3000 w.

11691. A Poor Diagram—Lead Changed with Every Change in Load. Ill. (B J C-April 1.) 600 w.

11692. About Lubricants—The Different Classes and Where Used (B J C-April 1.) 1300 w.

11701. The Velocity of Flow of Steam (S E-March 25.) 400 w.

*11750. Peculiarities in the Behavior of Steam Jets. Abstract of paper by John Aitken (P Eng-March 24.) 2200 w.

*11755. The Smokeless Combustion of Coal (A E R J-April.) 800 w.

*11775. Heat Movement in Steam Engine Cylinders (E R L-March 24.) 1300 w.

11776. Circulation of Water in Steam Boilers. Ill. Criticisms of G. H. Babcock's lecture. Fritz Krauss and John J. Hogan (P S-April.) 7500 w.

11818. Babcock and Wilcox Boilers. Over Puddling and Heating Furnaces. Ill. (Ir Age-April 6.) 2000 w.

Serials.

10946. Hints. W. H. Wakeman (M G-Began March 4—Ended March 11—2 parts—15 cts. each).

11001. Thermodynamic and Adiabatic Diagrams of Water and Steam. Ill. Robert H. Smith (I L-Began Feb. 24—Ended March 3—2 parts—30 cts. each).

11085. The Causes of Corrosion in Steam Boilers. William H. Edgar (S E-Began March 4—2 parts to date—15 cts. each).

11102. Progress in Steam Engineering. R. H. Thurston (E Mag-Began May—1 part to date—30 cts).

11138. Notes on the Steam Injector. Strickland L. Kneass (E M-Began March—1 part to date—30 cts).

11180. The Expansion of Water by Heat. G. W. Buckwell (S L-Began March—1 part to date—30 cts).

11720. Steam Boilers.—How they may be safely operated and economically handled (T-Began April 1—1 part to date—15 cts).

TELEPHONY AND TELEGRAPHY.

*11105. Professor Gray's New Telautograph. Ill. Wm. Maver, Jr. (E Mag-May.) 3000 w.

11270. The Telephone Situation (E W-March 18.) 1000 w.

11499. Prof. Elisha Gray and the Telautograph. Ill. (E W-March 25.) 4400 w.

11505. Unjust Law. A. B. Upham (E W-March 25.) 800 w.

*11555. Improvements in Single Needle Instruments. Ill. (E R L-March 17.) 600 w.

11601. Important Decision of the Supreme Court (E W-April 1.) 900 w.

11607. The U. S. Government Departmental Telegraph Service. Ill. George C. Maynard (E R N Y-April 1.) 1000 w.

11608. The Telegrapher's Tournament (E R N Y-April 1.) 600 w.

11661. Telephonic Communication without a Special Line. G. Mareschal (W E-April 1.) 400 w.

11780. Park Benjamin on the Telephone Patents (E W-April 8.) 850 w.

11784. Annual Report of the American Bell Telephone Company (E W-April 8.) 1800 w.

11795. The "Long Distance" Transfer Signaling System. Ill. (E E N Y-April 5.) 500 w.

MISCELLANEOUS.

*11100. Cotton as a Factor in Progress. Ill. D. A. Tompkins (E Mag-May.) 3000 w.

11110. Tobacco Culture in the South (M R-March 10.) 2500 w.

11111. Rubber From Cotton Seed Oil. C. B. Warrand (M R-March 10.) 800 w.

11132. India Rubber Trees (M G-March 11.) 1400 w.

11173. The Problem of Heating Houses. C. M. (A A-March 11.) 1400 w.

*11191. The Future of British Engineering. Charles S. Du Riche Preller (E-Jan. 27.) 3000 w.

*11211. Industrial Diseases and Their Prevention. Editorial (I L-March 3.) 1600 w.

*11212. Diseases Incidental to Work-People

in Chemical and Other Industries.—Abstract of Lecture by Watson Smith (I L–March 3.) 1500 w.

*11216. The Dynamics of Gravity; or Gravity Viewed as a Dimensional Property of a Gas. S. Tolver Preston (Eng L–March 3.) 1600 w.

†11253. Paint as Used in Engineering Constructions. Edward Hurst Brown (P E C P–Jan.) 4500 w.

11338. Some Misconceptions Concerning Asbestos. J. T. Donald (E M J–March 18.) 800 w.

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